A McGraw-Hill Weekly 75 Cents March 22, 1963

electronics

LASER IN A WINE CELLAR

Javan and Townes to check Einstein, p 74
(photo below)

COMPONENTS THAT LEARN

Four of five devices are magnetic, p 49

HOW SIDEVIEW RADAR WORKS

Electronic eye for Mach 3 planes, p 22

MEASURE MILLIVOLTS at 1000 MC

hp 411A RF Millivoltmeter now available. Measure low level radio frequency, radio frequency and intermediate frequency stage gain, and radio frequency in coaxial lines from 500 kc to 1000 mc, 10 mv to 10 volts. Measuring is simple, resolution is high, and thermal drift errors are virtually eliminated with the 411A Voltmeter. This remarkable instrument has true linear operation (no correcting networks) and readings are presented on a large, mirror-backed linear meter. Temperature stability is such that there is virtually no change from 10° to 40° C.

Specifications alongside indicate basic features of this important new, time-saving instrument. Other special features include: matched diodes protected against burnout; probe temperature compensated for low drift; amplifier photochopper eliminating contact noise, guaranteeing high sensitivity and zero-drift freedom; extra probe tips available including a 500 kc to 250 mc UHF tip, 100:1 Capacity Divider tip for measurements up to 1000 v peak, and Type N Tee tip for coax use to 1000 mc. Get a new 411A into action on your bench now!

SPECIFICATIONS

Voltage Range:

10 mv rms full scale to 10 v rms full scale in seven ranges; full scale readings of 0.01, 0.03, 0.1, 0.3, 1, 3 and 10 v rms

Frequency Range:

500 kc to 1 gc with accessory probe tips; usable indications to 4 gc

Accuracy:

500 kc to 50 mc, ± 3% of full scale; 50 mc to 150 mc, ± 6% of full scale; 150 mc to 1 gc, ± 1 db using appropriate probe tips

Meter Scales:

Two linear voltage scales, 0 to 1 and 0 to 3, calibrated in the rms value of a sine wave; db scale, calibrated from +3 to —12 db; 0 db=1 mw in 50 ohms

Probe Tip Furnished:

411A-21E BNC open circuit tip, 500 kc to 500 mc; shunt capacity less than 5 pf; max. input 200 v dc; input resistance at 10 mc typically 80K ohms

Galvanometer Recorder Output:

Proportional to meter deflection, 1 ma into 1000 ohms at full scale deflection

Power:

115 or 230 v ± 10%, 50 to 60 cps, 35 watts

Dimensions:

Cabinet Mount: 11¾" high, 7½" wide, 12" deep
Rack Mount: 6-31/32" high, 19" wide, 10⅜" deep behind panel

Price:

hp 411A, (cabinet) $450
hp 411AR (rack mount) $455

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

HEWLETT PACKARD COMPANY

1501 Page Mill Rd., Palo Alto, California, Area Code 415, DA 6-7000. Sales and service representatives in all principal areas, Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal

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March 22, 1963 Volume 36 No. 12

Published weekly, with Electronics Buyers' Guide 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.

OFFICERS OF THE PUBLICATIONS DIVISION: Shelton Fisher, President; Vice Presidents: Joseph H. Allen, Operations; John R. Callaham, Editorial; Ervin E. DeGraff, Circulation; Donald C. McGraw, Jr., Advertising Sales; Angelo R. Venezian, Marketing.

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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.

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

Audited Paid Circulation

CONTENTS continued

DEPARTMENTS

Impact of Microelectronics

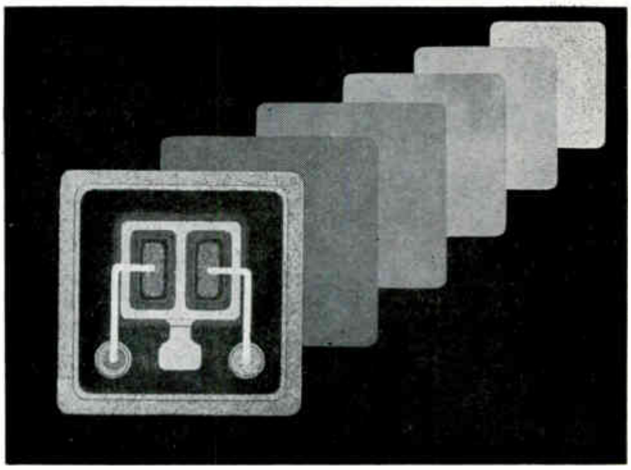
ON JUNE 26 and 27 in Chicago, ELECTRONICS will co-sponsor with the Armour Research Foundation of the Illinois Institute of Technology a conference on the theme "The Impact of Microelectronics."

Much information about the technical side of microelectronics has been published. ELECTRONICS itself has given full coverage to this aspect of the subject, and will continue to do so as new developments occur. However, we feel that our responsibility to the industry does not end there. We share with thoughtful people at Armour and elsewhere a deep interest in the changes being wrought in electronic products, and consequent changes in the traditional structure of the industry. It is in this spirit that this conference was conceived.

It is anticipated that prominent and knowledgable industrial, government and educational leaders will participate in the program, which is being designed to present a forum for the discussion of such vital subjects as the changing structure of the electronic components industry, changes in the vendor-user relationship, management of research and engineering for microelectronic systems, product status and forecasts of future trends. Time will also be allotted for presentation of brief reports on the latest technical advances.

ELECTRONICS and Armour believe the forthcoming conference will prove valuable to many people in the industry who will be involved in making the difficult decisions that will be required to reap the potential rewards of microelectronics. These decisions will affect many things in the future—from the direction of corporate policies to the courses of individual careers.

More details on the conference will appear in next week's issue.



LEARNING MACHINES. An article such as our lead feature this week (p 49) on adaptive or "trainable" system components would have been impossible to write a dozen years ago—not only because the components themselves had not yet been developed but because the underlying interdisciplinary approach had not yet evolved.

It was only a dozen years ago that a handful of reseachers gathered in Boston to discuss how scientists could pool their knowledge and break down the barriers between such diverse fields as physics, chemistry, psychology, mathematics, statistics and electrical engineering. All of these fields play an important part in development of trainable systems.

An example of how the interdisciplinary approach is gaining adherents and momentum is the turnout anticipated for the Bionics Symposium this week. Some 2,500 scientists and engineers are expected to gather at Dayton to hear reports on information processing by living organisms and machines.

While the five different variable-gain components discussed this week by Harold S. Crafts, of Stanford Research Institute, are not strictly speaking bionics devices, they represent developments complementary to bionics. For example, one can envision systems composed of variable-resistance memory elements interconnected in immense learning networks. Low-resistance paths would form in the networks as the machine gained experience—as it got smarter.

The probability that millions of such components will be used in the future should appeal to front-office personnel as well as researchers. The market for such components today is understandably small, since they cost about a dollar each. But a decade ago, they sold for $10. The day may come when they cost only a dime and are best-sellers.

Coming In Our March 29 Issue

ANTENNA SCANNING. Next week, we start off with a description of an electronic antenna scanning method that does not use phase shifters. Instead, a line of microwave receiving antennas are switched at high speed. Other upcoming features include:

- Automatic thin-film deposition control
- Overload protectors that do not rob power
- Using avalanche scr's in power supplies
- Magnetically coupled precision multivibrators
- Power and vswr monitor for h-f and vhf.

COMMENT

Microminiaturization

Just read your story on Advances in Microminiaturization (p 45, Feb. 15). It's great! And I can appreciate the time you must have spent on so comprehensive an article.

HAL GETTINGS
Dynatronics, Inc.
Orlando, Florida

Eyeglass TV?

I noticed in your Jan. 11 issue, in the article on New Tubes and Circuits (p 47), a box entitled "Eyeglass TV?"

Enclosed is a copy of the Oct. 1936 issue of *Shortwave Craft.* I believe I was the first to publicize this idea in 1936, when of course there was no regular television.

HUGO GERNSBACK
Gernsback Publications, Inc.
New York, New York

The editorial by reader Gernsback forecasts, in part:

You will use a tiny television receiver placed right on your very nose—a device which I term "television eyeglasses." These will be regulation eyeglasses, but instead of having the normal lenses, they will have a small projection of one or two inches which will house the entire television receiver. There will be two such receivers working in unison, giving you thereby a *stereooptical television view.*

Reentry Plasma Heating

I am presently engaged in applying lasers to plasma diagnostics, and am most interested by the short article, Reentry Plasma Heating Studied by Laser Technique, in your January 18 issue (p 59).

The technique described for measuring electron density and temperature is identical to that I am applying. I would very much like to contact those "Texas A&M College scientists" who have apparently beaten me to it.

Wishing you continued success in producing what I find to be a very stimulating and up-to-date magazine.

C. M. H. SHARP
Marchwood Engineering Laboratories, Marchwood, Hampshire, England

The project is headed by Dr. Melvin Eisner, research physicist, at Texas A&M College, College Station Texas. The NASA grant also assists six graduate students who are in Dr. Eisner's group.

Handwired TV

I noted on p 60 in the review of the consumer goods electronics market for 1963 (Jan. 4), a paragraph reporting that "hand wiring in construction of television sets has been reinstituted by several manufacturers reportedly as a means of gaining reliability and reducing service problems."

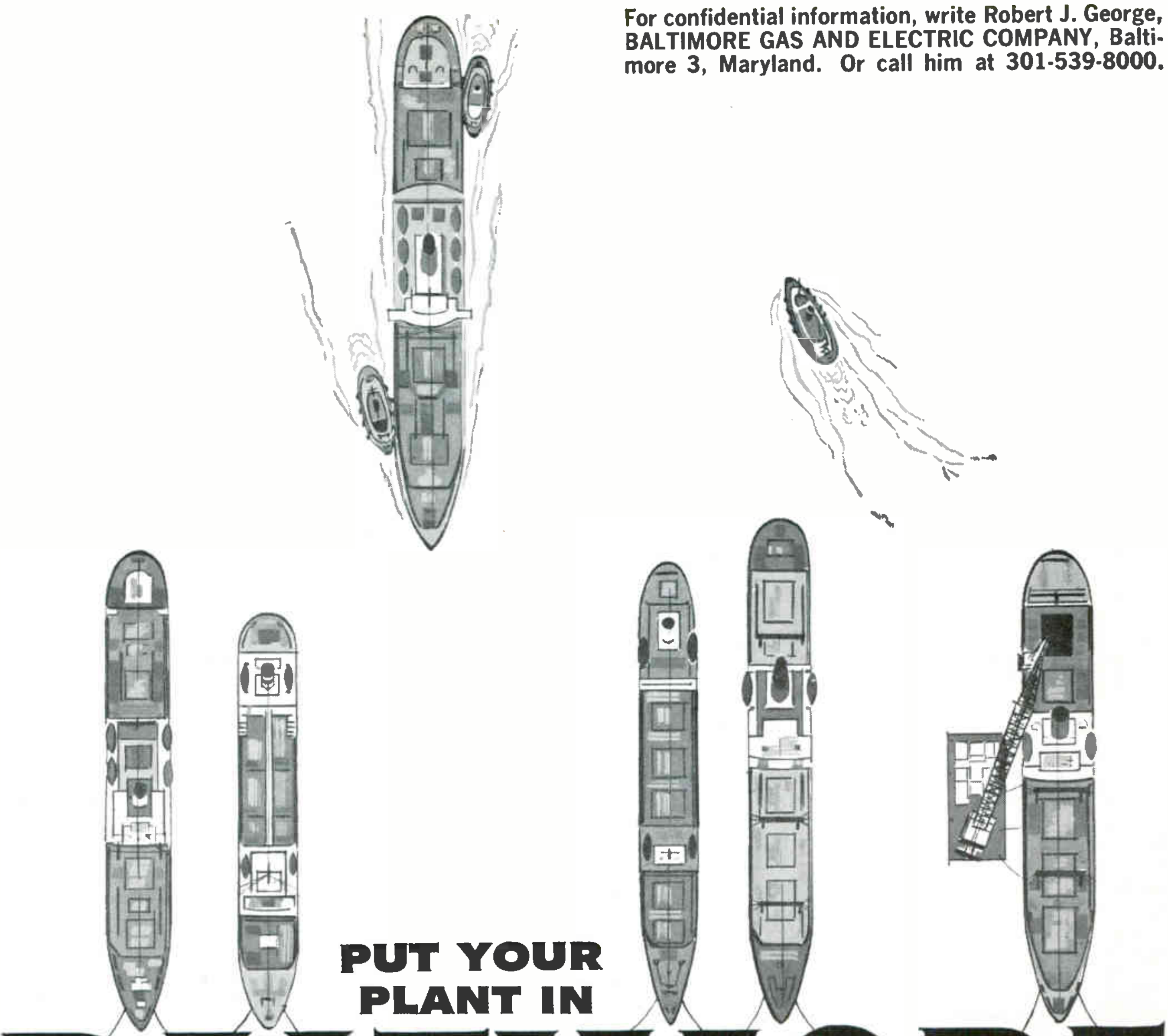
I should like to take exception to the implication in this paragraph that hand wiring in any way gains reliability or reduces service problems. The public controversy over the relative merits of printed circuitry and hand wiring is one purely of advertising, sales promotion and emotionalism. Any objective survey of the two systems shows no fundamental difference in reliability for well-designed products of either system, although I do believe there is better control over product uniformity with printed circuits. As to serviceability, a glance at modern printed circuit designs, with schematic diagrams printed right on the board, indicates that they are probably easier to service than hand-wired receivers.

It would be unfair of me to end this note of criticism without observing that I find your magazine consistently of great interest and stimulation and I look forward to its appearance on my desk every week.

DAVID SILLMAN
Manager of Engineering
Television-Radio Division
Westinghouse Electric Corp.
Metuchen, New Jersey

The implication is not ours, but that of several manufacturers who have returned to conventional wiring, and who told us why they did so.

For confidential information, write Robert J. George, BALTIMORE GAS AND ELECTRIC COMPANY, Baltimore 3, Maryland. Or call him at 301-539-8000.



PUT YOUR PLANT IN

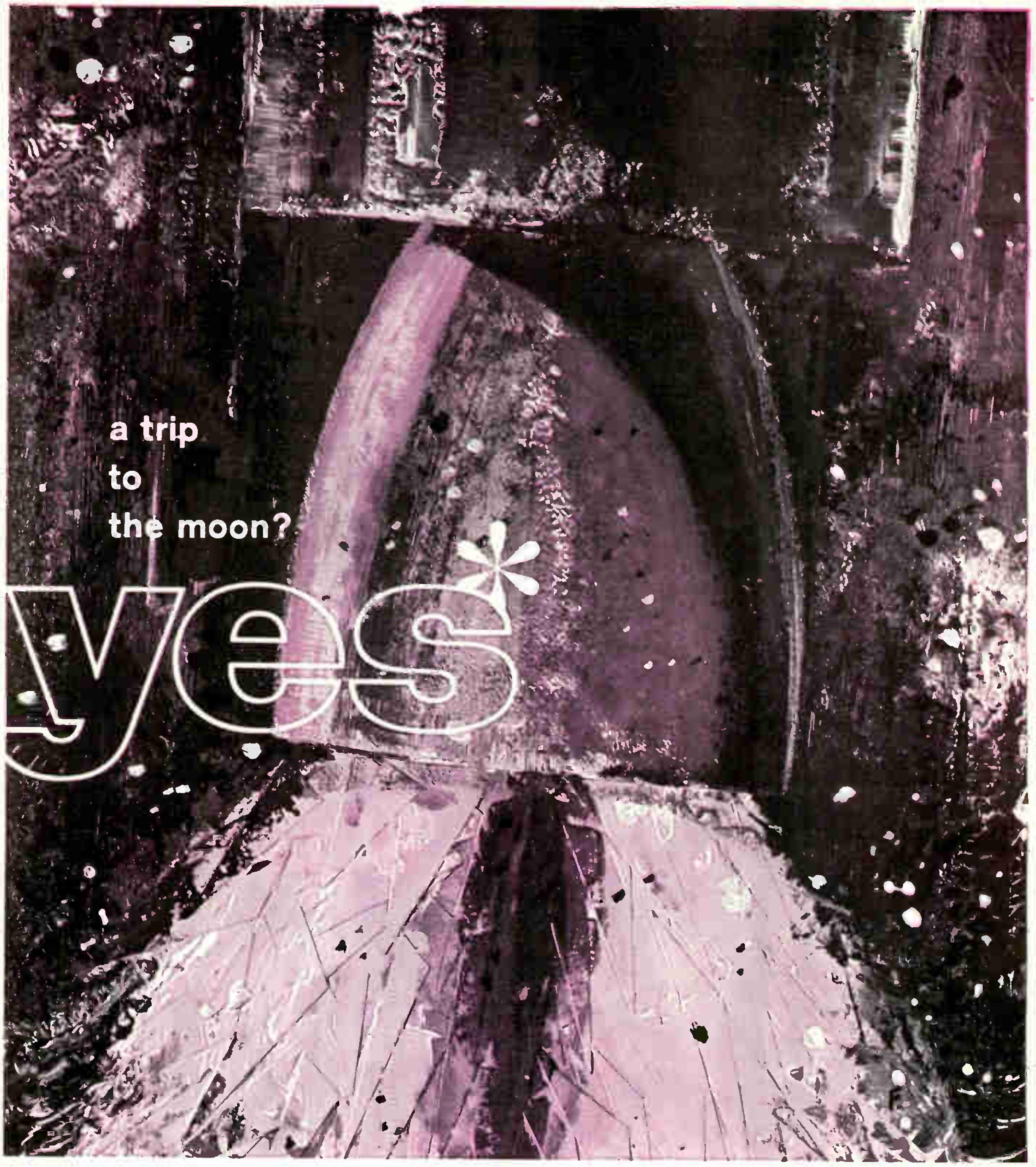
BALTIMORE

WHERE YOUR SHIP COMES IN DAY AFTER DAY

There's nothing like a port city to put you right next door to the world. And Baltimore is one of America's bustling and busy top ports . . . millions of tons per year move into or out of the holds of better than 5,000 ships. Nearer the Midwest, decidedly, than any other Eastern harbor, Baltimore gives you a vital edge in freight rates and speed.

Inland transportation, too, is equal to the port's demands . . . and yours. Trunk railroads, truck lines, and airlines make the Baltimore area a prime shipping hub for half the nation. All sorts of manufactured goods, all kinds of skilled labor are here. So are plant sites aplenty . . . including 2,500 zoned acres in 30 industrial parks. When you want to think big, think BALTIMORE.

CIRCLE 5 ON READER SERVICE CARD



Gamewell made a Master Pot with these characteristics: resistance, 31,500 ohms (nominal); total angle, 359.5°; resolution, .000055 (or approximately 1 minute of arc); linearity, ±.01° zero based; cam corrected; O.D., 8″; thickness, 2″; shaft, 1/4″; alignment boss, 1″ x 1/16″; and an anodized aluminum finish. This extremely accurate precision potentiometer demonstrates our ability to manufacture pots to meet the most demanding specifications — such as might be necessary on a trip to the moon. Write and tell us about your *special* pot problems. Chances are they can be solved by Gamewell's YES service — ***y**our **e**ngineered **S**pecials service. Your answer is YES.

GAMEWELL
ELECTRONICS DIVISION

THE GAMEWELL COMPANY, 1602 CHESTNUT ST., NEWTON 64, MASS. A SUBSIDIARY OF E. W. BLISS COMPANY

67 Firms Vie for Space Station Study

NASA'S MANNED Spacecraft Center (MSC) has received 67 proposals for a contract soon to be awarded for operations and logistic study of a manned orbital space station (MOSS). The study will establish preliminary design requirements for Moss and for a resupply spacecraft.

Twenty-two proposals have been received for a contract to study the electrical power systems for Moss. The study will encompass power generation, energy storage and power distribution for both Moss and the resupply spacecraft. MSC has also requested proposals for the environmental control and life support system for a large Moss.

Four Moss studies that MSC has not sent out yet are for definition of the configuration, preliminary design and program definition of (1) a manned rotating space station; (2) zero gravity manned space station; (3) a 5 to 6 man modified Apollo resupply spacecraft for space station support; and (4) a lifting body resupply spacecraft for space station support.

Proposals will be sent out by the Manned Space Flight Center (MSFC) for a study contract on the integration of orbital systems.

Super Laser Forerunner Of Anti-ICBM Device?

SPECULATION ON THE USE of superpower lasers for military radiation weapons has been aroused by the development of a 500-joule optically pumped laser by Radiation at Stanford (p 38, March 15). Reports say ARPA or AF may study the device in hopes of developing an anti-ICBM laser.

Laboratory experiments over very short distances have reportedly shown that Radiation's laser, using external focusing devices, can burn through a ½-inch steel plate. The laser, cooled by liquid nitrogen, has an array of eight flash lamps. These irradiate a 12-inch long, ⅝-inch diameter ruby rod.

Neodymium-doped glass rods can be used in place of the ruby crystal. Another version of the system using a 16-inch ruby rod is planned. A Kerr cell modulation system is employed to control pulse repetition rate. In one version of the instrument, this is one every four minutes.

Army Picks Developer For Anti-ICBM Missile

SELECTION of Martin-Marietta as development contractor for the Sprint missile, a major component of the Army's Nike X anti-missile system (p 24, March 8), was approved this week.

Amount of the initial subcontract will be about $5 million. Martin will be subcontractor to Bell Telephone Labs, system developer. Western Electric is prime contractor.

Sprint will use a solid-fuel rocket. It will be shorter, lighter and accelerate faster than the 48-foot-long Nike Zeus. Sprint's primary radar is Mar (formerly Zmar, being developed by Sylvania). Other radar will be needed.

Navy Fighter Getting Down-Looking Radar

WASHINGTON—The Navy is starting an "equipment improvement program" for the McDonnell F4H (now called the F4B) fighter plane, which the Air Force is also buying in quantity. Purpose is to give the plane what one admiral describes as "a downward radar look capability to pick up enemy aircraft at low altitudes." Raytheon is contractor for the new radar.

Electronic Tape Device Reads, Writes Maps

LONDON—Electronics map-making system will be developed by Dobbie McInnes of Glasgow under a $180,-

Computer Makes Room for Human Intuition

TECHNIQUES THAT BRING the basic research scientist and the electronics computer closer together have been developed by Thompson Ramo Wooldridge. Their purpose is to allow the scientist to make greater use of his intuition.

Direct two-way communication between scientist and computer is made possible by a console that has a tv-like screen and push-button controls labeled in scientific terminnology. From the console, the scientist can command the computer to make mathematical calculations for him. Answers are displayed on the screen. Much use is made of mathematical curves because they are familiar and because they convey information rapidly and efficiently.

In essence, the user is his own programmer. The user can string together any number of preprogrammed functions to create a new expression or formula to fit his problem. In demonstrations, the new console has been used with the TRW-400 'polymorphic' computer.

Another firm has obtained a similar console for an advanced information-retrieval system in which the user furnishes clues to the machine based on his partial recall and the machine hopefully can then answer his query. The console would be hooked to a large-capacity storage device such as a photostore and to a computer such as the IBM 7090

000 joint government-industrial contract. The system will read data from manuscript maps onto magnetic tape, and write from the tape directly onto the photographic negatives used for map printing.

Maps of any area, scale and color can be made automatically from the tape. Place names are inserted automatically in their correct position and size. The machine, due for completion by mid-1964, will produce shading patterns and fine line structures down to 0.0021 inch thick.

Limited-War Transceiver Demonstrated by Air Force

AIR FORCE was to demonstrate yesterday a two-channel four-transceiver unit weighing 37 lbs. It was developed by Sylvania in 120 days, for paratroop, antiguerilla air and troop control service in South Viet-nam. First public showing will be at the IEEE Show.

System is composed of two vhf transceivers, uhf and h-f transceivers. The h-f transceiver has 7-w voice and 5-w cw outputs and a range up to 500 miles. It can be used as a homing beacon for aircraft, as well as communications. The vhf and uhf units have 1 to 3-w voice outputs.

Contact Analog Displays Will Guide Submarines

CONTACT ANALOG DISPLAY systems for the automatic control of many of the piloting maneuvers of submerged submarines are now being produced by United Aircraft under a $1,126,000 Navy contract.

As the submarine moves submerged, the commander or diving officer feeds into a display generator information on the desired course, speed and depth. A synthetic picture on a 19-inch tv screen provides the pilot with a "roadway" with a floor and ceiling that mark the proper course and the bottom and the surface of the ocean.

New Conductance Unit?

INTERNATIONAL Electrotechnical Commission's Technical Committee 25 on Letter Symbols and Signs has circulated a draft for the fourth edition of its publication 27 "International Letter Symbols Used in Connection With Electricity."

A new unit appears for the quantities: conductance, admittance and susceptance. It is the siemens (S)—that's all there is, there isn't any mho

New Bionics Hardware Exhibited at Dayton

DAYTON, OHIO—Three new bionics systems were on display this week during the Air Force-sponsored bionics symposium, attended by some 2,500 scientists.

In addition to the frog's eye model (p 18, March 8), there was a system called Lannet (Large Artificial Nerve Network) developed by Melpar, and an electrical cochlea built by the Bio-Acoustics Lab.

Lannet, a high-speed self-organizing system, contains 1,024 statistical switches (or 250 Artrons—see p 18, June 1, 1962).

A mathematical theory for such equipment as phonetic typewriters was also presented. One is being developed at the Air Force Aerospace Research Labs here.

Use in Spectroscopy Seen for Hydrogen Maser

BOSTON—The hydrogen maser may turn out to have important applications in spectroscopy and chemical analysis as well as being a basic research tool and an extremely sensitive magnetometer.

In an IEEE lecture last week, Asst. Prof. Daniel Kleppner of Harvard told of experiments now underway in which a foreign gas is introduced into the maser cavity and interacts with the hydrogen, giving researchers a direct look at molecular reactions in the gas state.

A tantalizing idea, said Kleppner, is the multiplication of the hydrogen maser frequency up to optical bands and use of it to stabilize a gaseous laser to a definite and precise frequency.

In Brief . . .

INFEROMETER using a helium-gas neon laser has detected motion to an accuracy of 1/24,000 of a wave length of light, says North American. Device can also measure distances as small as the 'gap' between two atoms, 10^{-9} inch, the firm said.

NASA MAY LAUNCH Scout rockets carrying French instrumented payloads to study very low frequency electromagnetic waves at 46 to 62-mile altitudes.

LIGHTWEIGHT AIRBORNE multiplex system has been developed by Electronic Communications Inc. Firm says unit is one-half the size and one-third the weight of other systems.

TWT AMPLIFIER for use in a military communications satellite system will be developed by Watkins-Johnson for the Army.

ARMY WILL SPEND $31 million in 1964 on Redhead and Roadrunner target missiles. North American is prime contractor.

RECORD for long-distance space communication has been claimed by Russia. Tass said telemetric data was received last week from the Mars-1 interplanetary rocket while it was 61.095 million miles away.

LASER system which doubles the efficiency of data transfer by light beam has been developed, says Sylvania.

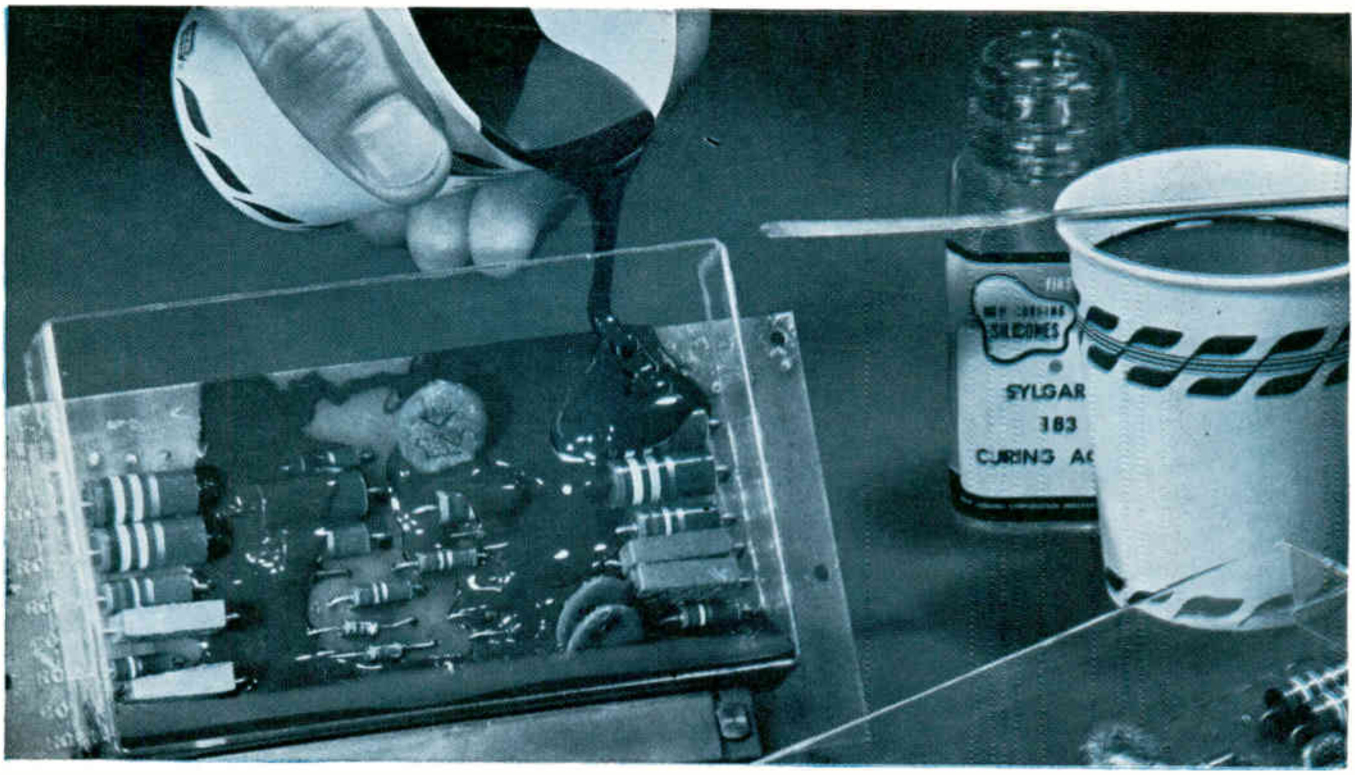
JOINT PROPOSAL will be submitted by Hughes, Douglas and FMC Corp. on AADS-70, Army Air Defense System—1970.

SALES OF FIRMS recently reported include: Hull Instruments to Century Geophysical; Granite State Machine to Shieldtron; H. O. Boehme to Pakco; Advanced Scientific Instruments, Inc. to Electro-Mechanical Research, Inc.; A&M Instrument to Loral; Kar-Trol Signal to Tamar, partner company of Electro-Science Investors, Inc.

NASA GAVE Textron $1.5-million contract to make Satan (Satellite Automatic Tracking ANtenna) systems.

SILICONE NEWS from Dow Corning

Embed, pot, encapsulate



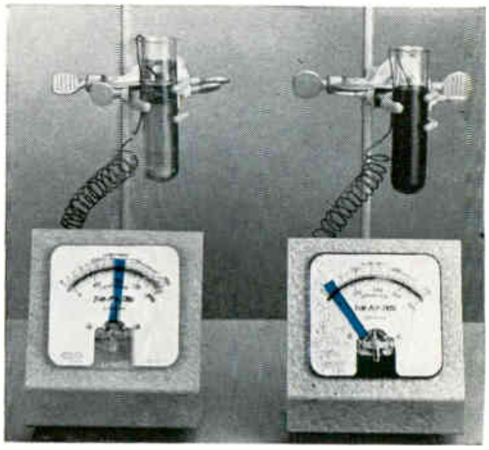
Cut encapsulating costs with tough, flexible, easy-to-use Sylgard® 183

This new, opaque, solventless silicone resin protects intricate components against heat, moisture, shock, vibration, ozone, voltage stress and thermal cycling. Combining toughness with flexibility, Sylgard 183 offers long pot life, deep section cure, and requires no post cure.

Fast, easy to use. Supplied as a low viscosity black fluid, Sylgard 183 flows freely and smoothly into place after blending with a curing agent. When heat is applied, the material sets up without exotherm to form a tough-but-flexible dielectric material. Recommended curing schedule: four hours at 65 C (150 F); can be varied from 15 minutes at 150 C (300 F) to 24 hours at 40 C (100 F). Sylgard 183 cures in sections of unlimited thickness even when completely sealed; is usable at temperatures from −65 to 250 C (−85 to 500 F) immediately after curing.

Repair of sealed components is simple: sections of the resin are cut out, repairs made, new Sylgard 183 poured in place. The new resin bonds tightly to the original embedment. Sylgard 183 is compatible with a wide range of materials including metals, plastics, glass, asbestos, natural and synthetic fibers, and ceramics.

Physically, dielectrically tough. When cured, Sylgard 183 retains its properties over a wide range of temperature, frequency and humidity; is effective from −65 to 250 C; shows no significant change in physical or electrical properties after 1,000 hours of continuous aging at 250 C; has tensile strength in the range of 800 to 1,000 psi.



Test shows absence of exothermic heat. Sylgard 183 (right) holds room temperature throughout cure; organic material (left) generates temperatures of more than 400 F.

CIRCLE 289 ON READER-SERVICE CARD

Dow Corning is your best source for a broad line of silicone fluids, gels, elastomers and rigid forms for potting, filling, embedding and encapsulating.

first in silicones

Dow Corning

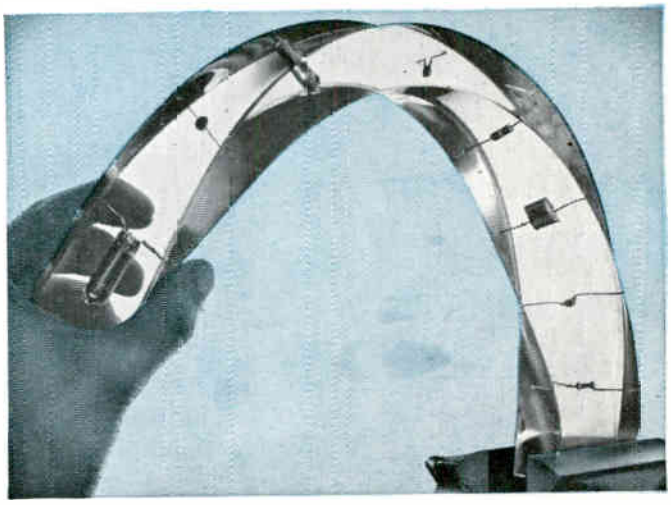
– with these silicones

See-through embedding

Supplied as an almost colorless liquid, Sylgard 182 solventless silicone resin pours easily in place; forms a tough transparent mass that provides maximum protection and complete visual inspection of components. Sylgard 182 features a cure schedule similar to that of Sylgard 183; offers equal curability in thick sections, and in confined spaces; has good dielectric properties and moisture resistance. Long service life from —65 to 200 C.

Elongation is in the range of 100%; tensile strength from 800 to 1,000 psi. Repair of embedded parts follows same procedure as for Sylgard 183.

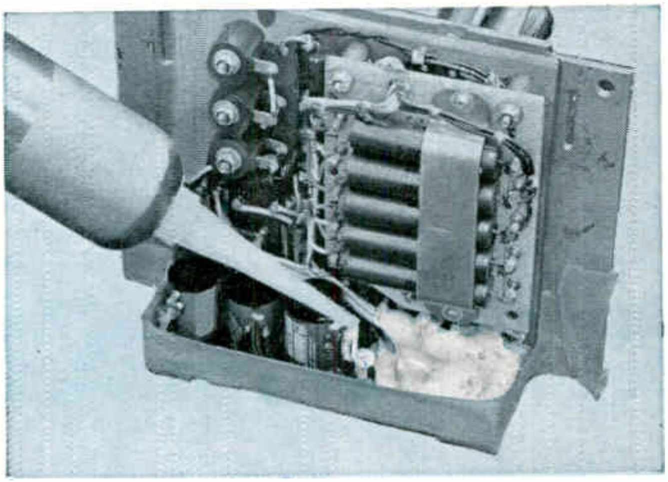
CIRCLE 290 ON READER-SERVICE CARD



Resilient encapsulating

Silastic® RTV silicone rubber cures without heat to form a tough, rubbery dielectric mass. Available in several colors and grades, it is easily applied by caulking gun or by pouring. Though higher in viscosity than Sylgard 183, it flows smoothly around delicate components without stress or pressure; forms a solid rubber jacket that protects from —55 C to about 250 C (—67 F to about 482 F); resists weathering, moisture, ozone, corona, shock and vibration. Repair of encapsulated circuits or components is easy, using a procedure similar to that detailed for Sylgard 183.

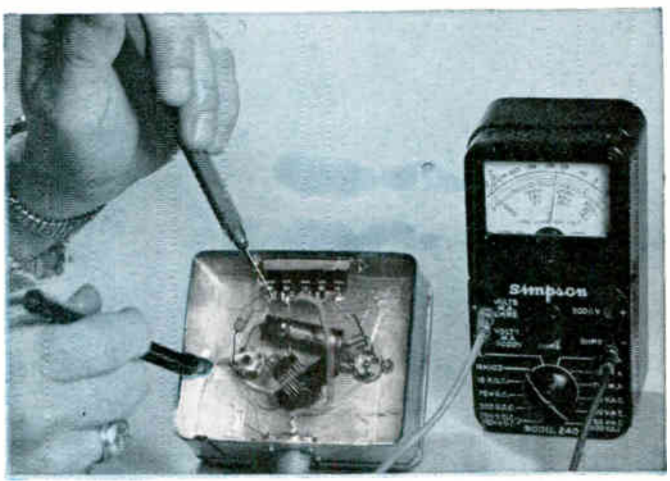
CIRCLE 291 ON READER-SERVICE CARD



Self-healing protection

This clear potting compound pours easily into assemblies; fills all voids; exerts negligible stress on components; cures to a jelly-like, transparent, resilient mass without exotherm. Curing time can be varied from 30 minutes to 48 hours; curing temperatures from 40 to 150 C. Potted parts can be quickly checked, either visually or by instrument probe. When probe is removed, Dielectric Gel reseals itself with no alteration of properties. Fully cured, it is self-healing from —60 to 200 C (usable to —100 C) has exceptionally stable dielectric properties; resists moisture; will not revert to fluid. Repair procedure is similar to that previously described.

CIRCLE 292 ON READER-SERVICE CARD



Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 3915, Electronic Products Division, Dow Corning Corporation, Midland, Michigan.

WASHINGTON THIS WEEK

BIGGER ISSUE UNDERLIES RS-70 DEBATE IN CONGRESS

DEFENSE SECRETARY McNamara underwent a scorching Congressional attack last week, reflecting growing antagonism to his policies. At issue, specifically, are his refusal to push RS-70 development and his reversal of a military recommendation on the TFX contract award (ELECTRONICS, p 12, March 8, and p 12, March 15).

Behind these specifics, however, is a broader issue: who should dominate defense policies? McNamara dominates the military as none of his seven predecessors were ever able to—or probably even wanted to. In doing this, he has substantially reduced the influence of military professionals and of Congress itself. McNamara was denounced by a ranking Republican (Rep. Arends of Ill.) as a "dictator" and "monarch" and was castigated by a Democrat (Rep. Hebert of La.) for disregarding "military judgments."

The House again backed the Air Force on the RS-70 issue, voting a $15.9-billion weapons authorization bill that includes an extra $363.7 million for two planes equipped as complete weapons systems. But there is little doubt that McNamara will again refuse to expand the program. He may even get support from the Appropriations Committees, which have yet to act on next year's defense budget.

DEPARTMENT OF SCIENCE PUSH RENEWED

INFORMATION HANDLING problems in science and technology—source of growing government concern—is becoming a lever for Congressional pressure to reorganize the government's entire science and technology structure. Organization of information retrieval and distribution took up a major portion of a report by the Senate Government Operations Committee recommending establishment of a Hoover-type commission to study government science organization.

The Senate passed the study bill that is now under consideration in the House—with better chance of passage than in previous years. The commission bill, its supporters hope, could lead to the creation of a federal department of science at the Cabinet level.

GEMINI FAVORED OVER DYNA-SOAR

CANCELLATION of Air Force's manned space project Dyna-Soar is expected soon. McNamara has told Congress that it makes little sense to spend around $800 million to develop the single-man Dyna-Soar vehicle with first manned flight set for 1965 while NASA is spending a like amount to develop the two-man Gemini spacecraft with first manned flights due in 1964. While Dyna-Soar has more maneuverability, McNamara contends it may be better to modify Gemini and cut out Dyna-Soar, on which $200 million has been spent.

SEA HAWK TO SAIL IN 1965

NAVY HAS SET 1968 as the target date for operational deployment of its first Sea Hawk advanced antisubmarine-warfare vessel (ELECTRONICS, p 12, Feb. 15). First prototype ship will be built not later than fiscal year 1965. Meantime, development of active and passive sonar components and navigation, command, and control systems is being accelerated. In the upcoming year, prototype tests of an integrated sonar system and other asw components will be conducted aboard an experimental escort ship (AGDE-1).

Here's a valuable new find in your endless quest for significant design advantages — Hitemp's "TWR" Ribbon Cable. Lighter than round conductor cable, "TWR" separation of individual conductors is controlled to 15-20 mils spacing, with its flat configuration offering unlimited design possibilities in terms of the number of conductors, types and sizes of wires and cables, and color coding, among other specifications.

In such difficult applications, for example, as situations where lateral movement is unavoidable, "TWR" Ribbon Cable has exceptional durability because the unsintered Teflon tape covers 90% or more of the outer surface — reducing wear to an absolute minimum.

And Hitemp also makes other ribbon cables with Teflon insulated wires — one where individual insulated conductors are heat bonded together, Type "ER", another where individual insulated conductors are woven with either Dacron, Rayon, Nylon, or Teflon yarn, Type "TR". TWR, ER, and TR ribbon configurations are perfectly suited to miniaturized components, restricted packaging, and point-to-point contact for hook-up of control, signal, and power circuits.

So, now you can relax whenever size, weight, abrasion resistance, flexibility, *and* reliability are critical — because Hitemp's Teflon insulated Ribbon Cables provide *the* safe, sound solution.

SEND FOR NEW BULLETIN No. 100 for the full details on HITEMP Ribbon Cables. Or, send along a piece of what you're currently using — we'll evaluate it carefully and advise you of any savings you might be able to achieve with Hitemp's Teflon insulated Ribbon Cables. Take advantage of either or both offers right now.

HITEMP WIRES CO.

a Division of Simplex Wire & Cable Co.

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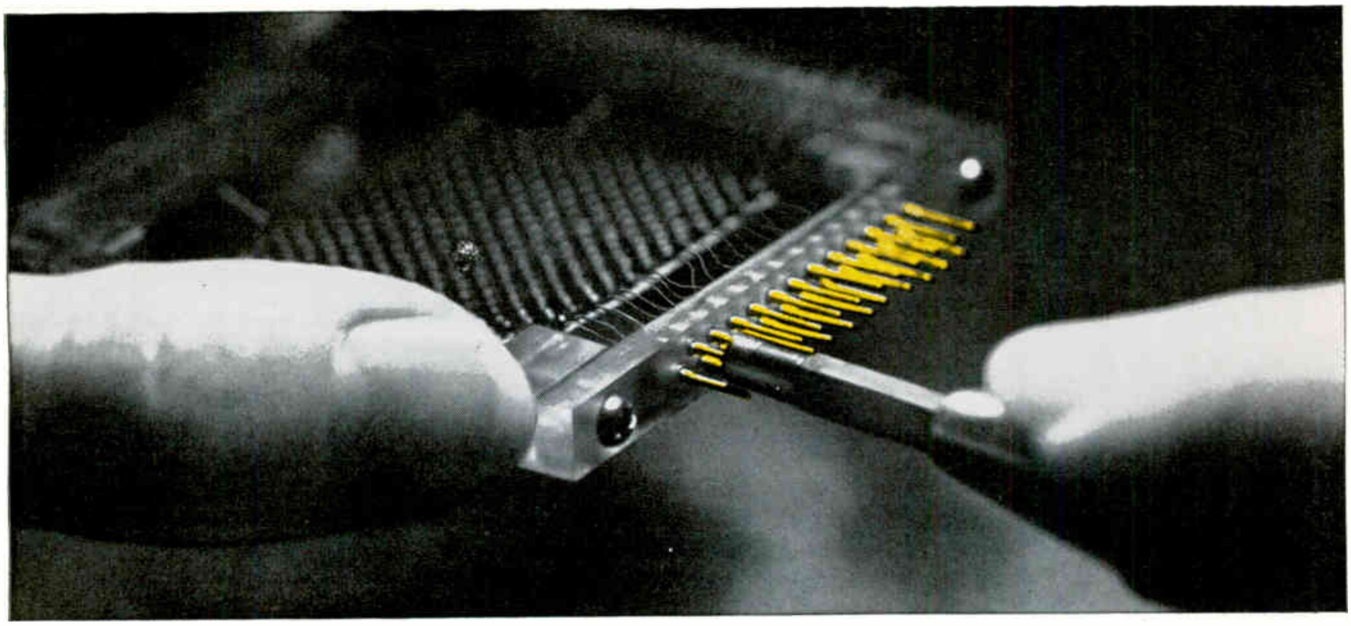
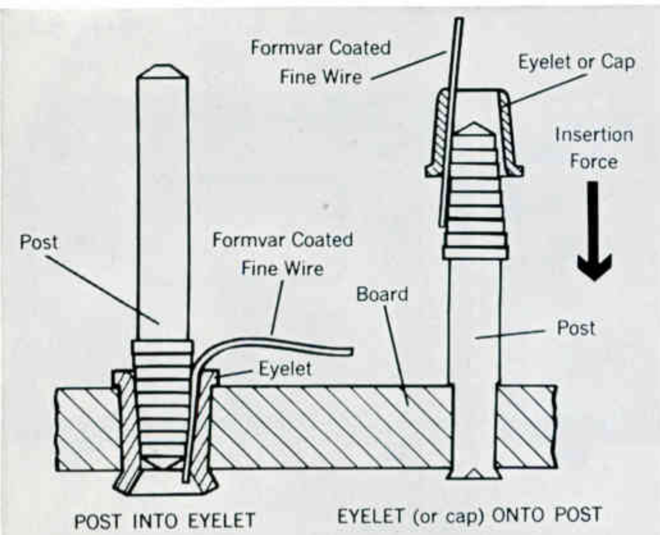
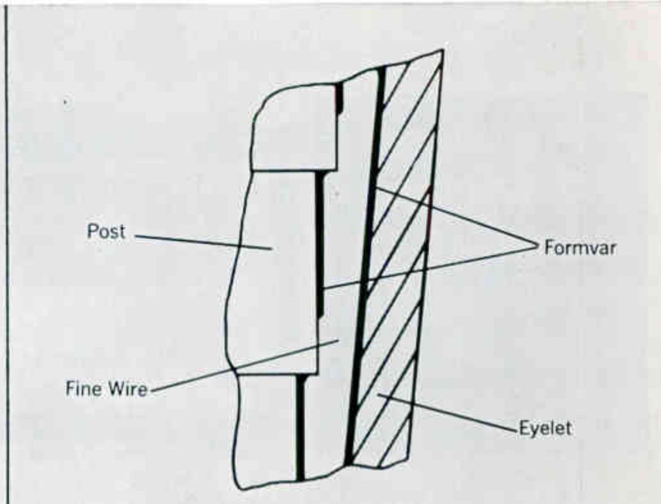


Fine wire finesse!



APPLICATION OF FINE-Y-R TERMINATION



CROSS SECTION OF POST IN EYELET

Visit us at the IEEE Show
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The AMP FINE-Y-R* Termination's wedge fit does away with time consuming and costly insulation stripping. Makes possible the handling of fine wire, in wire range size #26 through #56 AWG, without burnt insulation, cold solder joints, embrittled conductors and oxide contaminations! You get a reliable, virtually gas-tight connection whose parts can be used again and again . . . removed and reused up to 5 times, if necessary!

A precision-tapered post evenly spaced with concentric serrations, a matching capping sleeve or eyelet and a specially calibrated application tool . . . that's all that's needed. When these elements go to work, the bared wire molds snugly over the points of serration and produces an electrical connection as good as the wire itself.

If you're using fine wire in any type application, you can now make quicker connections and at a fraction of your present cost with AMP FINE-Y-R Terminations.

Put finesse in your fine wire applications by sending for complete details today!

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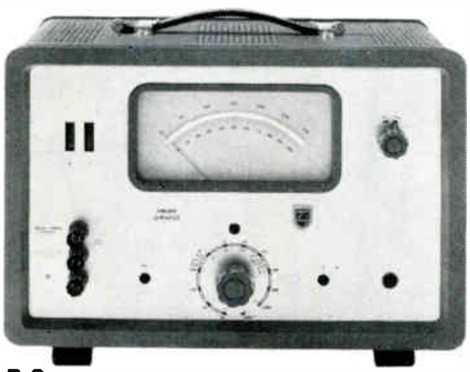
CIRCLE 15 ON READER SERVICE CARD

an ample choice of Philips electronic voltmeters

available now

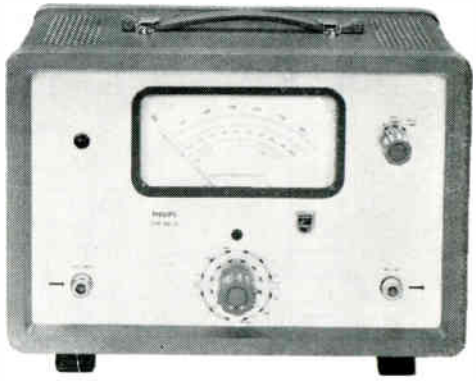
Philips voltmeters cover
every practical need
for accurate measurements
in the DC-LF-HF
and UHF ranges.

AMPLIFIER mV-METERS



D.C.
GM 6020

Range (fsd) 100 μV - 1000 V
Input impedance
Input I 1 MΩ
Input II 100 MΩ
Accuracy 3%
Predeflection < 5 μV
Automatic polarity indication
DC current measurements
(10 $\mu\mu$A - 10 μA); with UHF probe
for AC measurements up to 800 Mc/s,
as an indicator up to 4000 Mc/s.



L.F. 2 c/s - 1 Mc/s
GM 6012

Range (fsd) 1 mV - 300 V
-80 dB to +52 dB
Input impedance
(1 mV - 3 V) 4 MΩ // 20 pF
(10V-300V) 10 MΩ // 10 pF
Accuracy
(5 c/s - 100 kc/s) 2.5%
(2 c/s - 1 Mc/s) 5 %
Calibration voltage 30 mV and 10 V
Amplifier output 50 x

PHILIPS *electronic measuring*

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GM 6001

DC Range (fsd) 300 mV - 1000 V
with EHT probe up to 30 kV
Input impedance 10 MΩ - 100 MΩ
Accuracy 2.5 %
AC 20 c/s - 1000 Mc/s
Range (fsd) 1 V - 300 V
Input capacitance 3.5 pF
Accuracy 3 %
Resistances
Range 1 Ω -1000 MΩ (centre scale values 10 Ω - 100 MΩ)
Special features
Floating input. Centre scale facility.
Calibration voltage incorporated.
Special heater stabilisation.

GM 6000

DC Range (fsd) 1 V - 1000 V
Input impedance 10 MΩ
(with probe GM 6070: 1000 MΩ)
Accuracy ± 3 % of full scale
AC (20 c/s - 100 Mc/s)
Range (fsd) 1 V - 300 V
Input impedance at 1 Mc/s
1.2 MΩ //8 pF
Accuracy ± 3 % of full scale
Resistances
Range 10 Ω - 5 MΩ
Floating input.
Calibration possibility incorporated.

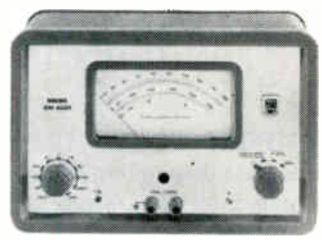
UNIVERSAL VOLT-OHM-METERS

H.F. 1 kc/s - 30 Mc/s
GM 6014

Range (fsd) 1 mV - 30 V
-80 dB to + 32 dB
Input impedance
without attenuator
1 MΩ - 50 kΩ//7 pF
with attenuator
50 MΩ - 2 MΩ//2 pF
Accuracy 3 %
Calibration voltages 30 mV and 3 V

U.H.F. 0,1 Mc/s - 800 Mc/s
GM 6025

Range (fsd) 10 mV - 10 V
-60 dB to + 22 dB
Input impedance at 200 Mc/s
35 kΩ//1 pF
Accuracy 5 %
Calibration voltages for each range
Probe-diode quickly exchangeable
T-piece for measurements on 50 Ω-coaxial lines available



Simple L.F. millivoltmeter
GM 6023

Frequency range 10 c/s - 1 Mc/s
Measuring range 10 mV (fsd) - 300 V
-60 dB to + 52 dB
Overall accuracy 5 % (from 20 c/s - 200 kc/s); 8 % (from 10 c/s - 20 c/s and 200 kc/s - 1 Mc/s)
Input impedance 1.5 MΩ//25 pF (10 mV - 1 V); 1.5 MΩ//15 pF (3 V - 300 V)
Pre-deflection < 300 μV
Calibration voltage incorporated

instruments: **quality *tools* for industry and research**

PHILIPS

CIRCLE 17 ON READER SERVICE CARD

Mercury To Carry New Experiments

Capsule will carry tv, more power, and make radiation measurements

By JOHN W. WASIK
McGraw-Hill World News

CAPE CANAVERAL—Astronaut Leroy Gordon Cooper, Jr., is expected to carry his own television camera into orbit with him on the next Mercury orbital flight, scheduled for May 14 at the earliest.

The tv camera is one of several experiments slated for Spacecraft 20 that have not been tried before.

The tv camera, produced by Lear-Siegler, will monitor the astronaut's well-being, obtain back-up readings of the instrument panel and observe tests and external phenomena through the spacecraft window.

Though the tv experiment is planned for the flight, it is not yet a definite part. Some system requirements were still to be met. The 10-lb camera will consume 56 watts during operation.

The tv transmitter serves a dual purpose. It will transmit the tv output directly to the ground over the higher of the two Mercury telemetry frequencies and, in emergency, will back up telemetry.

The emergency telemetry signals sent over this unit will be picked up by all ground stations, but the tv signal can be picked up only at Cape Canaveral and two other stations. Special equipment will reconstruct the picture transmitted at 0.5 frame/sec. Slow scan is used because of on-board size and weight restrictions.

OTHER EXPERIMENTS—Radiation measurements at spacecraft altitudes will be made on Cooper's flight with Geiger-Muller counters. Scientists hope to learn more about fission electrons trapped in the earth's magnetic field, gain additional data on the decay of the artificial radiation belt, and the preferential direction of radiation at the spacecraft. One G-M tube, sensitive to electrons of 2.5 to 10 Mev, will survey the heat shield region where external radiation is most likely to reach the pilot. Another tube, sensitive to electrons of 0.25 to 10 Mev, will register incoming radiation along the Z axis.

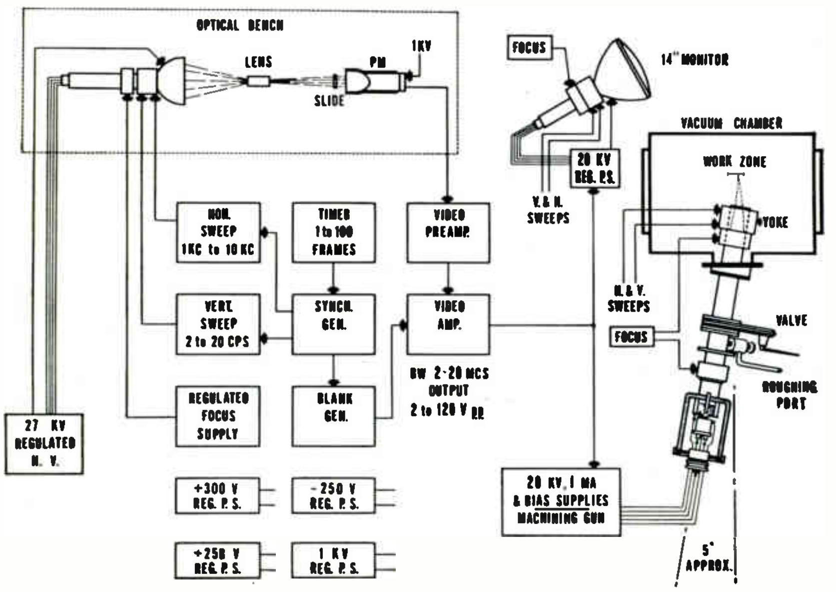
With associated counting circuits, both tubes will measure rates as high as 2×10^7 counts/sec. A high-voltage power supply will maintain an operating plateau of approximately 550 volts across each tube.

Electrical changes in the spacecraft were made primarily in the power supply and communications systems.

MORE POWER—Stand-by battery supply has been increased and a second battery has been added to

Electron Beam Builds Microcircuits

STAMFORD, CONN.—CBS Laboratories has begun building a fully automated electron-beam microcircuit processor under a contract from U. S. Naval Avionics Facility, Indianapolis. The processor could be used for welding, etching, alloying, polymerization or dissociation and surface conditioning of microcircuit substrates. Theoretically transistors as small as 2×2 microns can be fabricated according to W. W. Gaertner, vice president of the solid-state physics dept. In addition, electronic programming of the beam makes masking the sample unnecessary, he said.



TELEVISION MONITOR *displays pattern being machined*

After initial alignment in the vacuum chamber (see illustration), the electron beam is positioned on the substrate by a flying-spot scanner that views a 35-mm photographic slide. The beam traces over the substrate at the same rate and relative position as the flying spot working on the substrate only where the scanner views a transparent portion of the slide.

Transparency and substrate are scanned with a 2,000-line tv raster that may be varied from 1½ by 2 inches down to ⅜ by ½ inch. Total exposure time may be varied from 50 milliseconds to 50 seconds.

The electron gun has produced 2 megawatts per sq inch, enough to etch through tungsten foil over ⅜ by ½ inch in half a second.

And Slow-Scan Tv

the sequential circuit to insure proper indication of all critical events on the astronaut's control panels.

To conserve power, the telemetry transmitters will not operate continuously throughout the mission. The astronaut, or ground control, will be able to switch the transmitters on and off. This will be the first time an astronaut will be able to isolate himself completely from ground control.

To conserve weight in the craft and because of past reliable performance of the main uhf voice transmitter/receiver, the backup unit has been deleted from Spacecraft 20. To preserve the remaining unit, the flight plan calls for disabling the unit during descent from 10,000 feet to impact.

The whip antenna has been modified also. Previously, this antenna would deploy automatically upon impact. Communications problems in previous flights may have been because the antenna deployed underwater.

Cooper will deploy the antenna after he is certain the spacecraft is upright in the water.

Tv Eases German Auto Jams

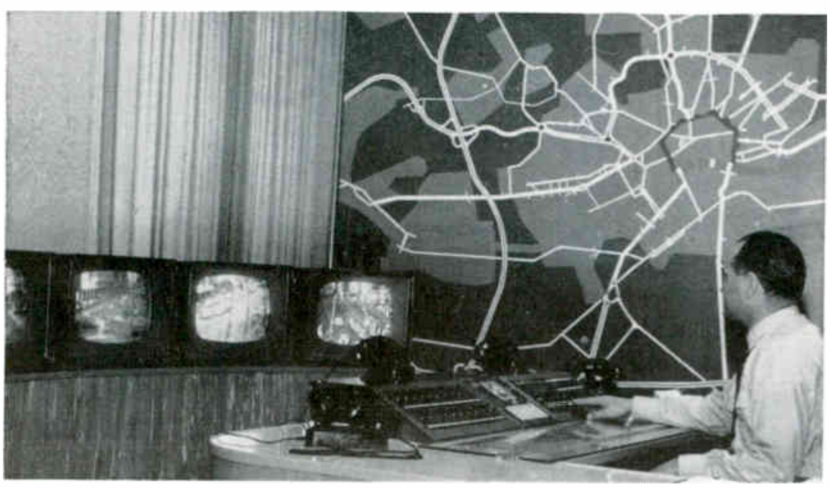
Six West German cities are using television to monitor traffic

BONN, GERMANY — Six West German cities have installed automatic traffic control systems in the past three years, and five others are currently running extensive tests on them.

Systems now in use include these features:

- Closed-circuit tv, usually with both stationary and rotating cameras.
- Cameras with both wide-angle and telescopic viewing capabilities and automatic light meters.
- Coaxial cable transmission of tv signals over short distances, reliance on 7 Gc directional beams over longer distances.
- Manual control automatic systems in case of special traffic situations.
- Temporary installations for trade fairs.

The six cities with the control systems are West Berlin, Munich, Frankfurt/Main, Stuttgart, Hamburg and Hanover. Grundig and Siemens, whose systems are being tested in other cities, will not name the cities involved.



TRAFFIC CONTROLLER *watches closed-circuit tv receivers at Frankfurt/Main police headquarters. Map shows city's main thoroughfares*

Side-Looking Radar Makes Maps In Flight

High-resolution airborne radar for complex target intelligence rivals cameras

By LEON H. DULBERGER
Associate Editor

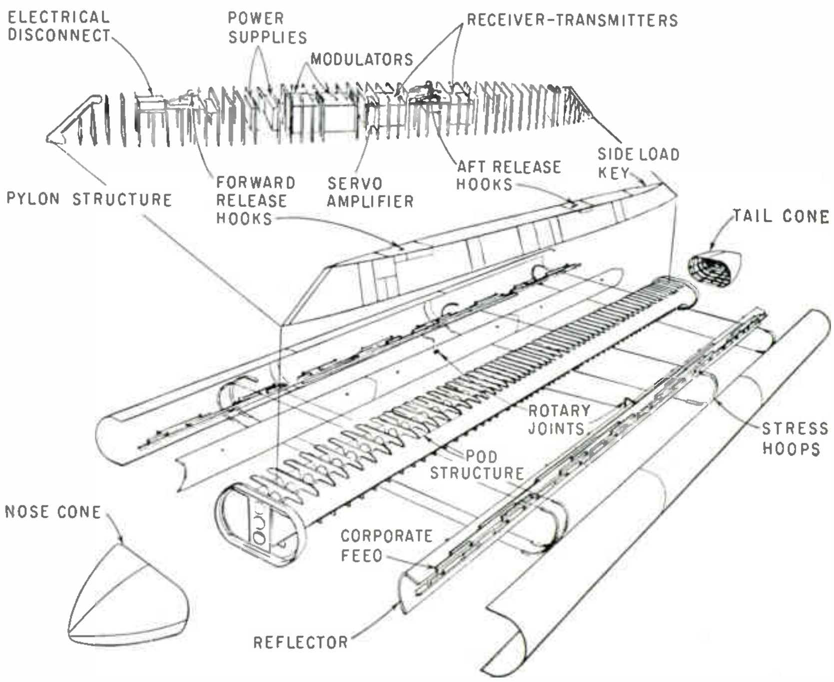
AIRBORNE RADAR for military use has undergone a quiet revolution during the last half decade. Presently, side-looking airborne radar (slar) using synthetic aperture antennas, provides high-resolution strip maps with photographic-like detail.

Early interest in side-looking techniques fostered development of radar systems allowing surveillance missions to be performed from the air without overflying unfriendly territory. Instead, aircraft fly along the edge of terrain of interest and direct a beam at right angles to the direction of flight.

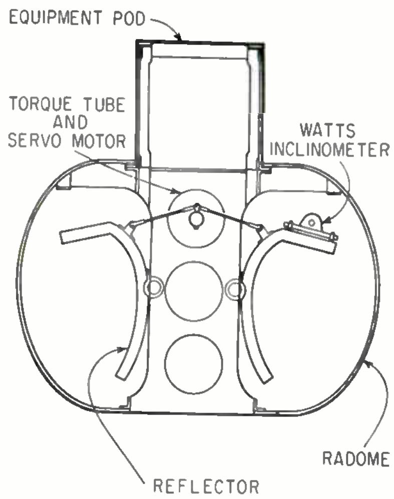
The side-looking orientation of the antenna and forward motion of the aircraft, permitted evolution of techniques leading to extremely high-resolution radars. Special signal processing techniques produce radar maps with a resolution of 20 feet in 100 miles, obtained with aircraft traveling at altitudes up to 70,000 feet. Modern slar systems, with antennas looking left and right, are used on overfly as well as flyby missions when superior resolution is required.

ANTISUBMARINE USES—These same signal processing techniques readily provide a display which differentiates submarine snorkels from background sea clutter—valuable in antisubmarine applications.

The use of a single-sweep mode in some side-looking airborne radars makes enemy jamming dif-



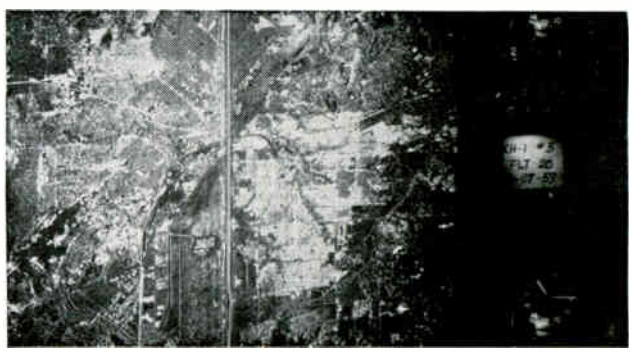
ANTENNA POD *and electronics pylon of side-looking airborne radar, in exploded view. A series of 32 slotted-waveguide arrays are used as a line source feed for each of the two roll-stabilized antennas. Air Force system operates at X-band, with 240-Kw peak power*



AIRCRAFT ROLL *servo system is used to correct antenna angle. Roll stabilization of ± 4.5 degrees is achieved with transistor-magnetic amplifier servo systems, using aircraft's stable platform as reference*

SIDE-LOOKING RADAR FOR RS-70

Engineers experienced in side-looking airborne radar say that the present state-of-the-art is adequate to design and produce radar required for Air Force's RS-70, Mach-3 aircraft (p 18, Feb. 1). They point out that all of the techniques needed to meet Air Force specifications have been demonstrated. But, they claim, the Department of Defense is requesting greater resolution than Air Force says it needs



STRIP MAP *obtained with side-looking radar illustrates high resolution. Map is made with antennas looking left and right, seam indicates aircraft line of flight*

Yours in this hp

STANDING WAVE INDICATOR

- **Pinpoint resolution for precise attenuation measurements**
- **Scale expansion with no "blind spots no resetting**
- **Built-in bolometer protection**
- **AC or battery operation**
- **All solid state design**

Model 415D Standing Wave Indicator is a high-gain, low-noise solid state amplifier and voltmeter calibrated for square-law detectors to read directly in SWR or db. The amplifier is tunable, 980 to 1,020 cps, for matching source modulator or for optimizing several instruments in one system. Variable bandwidth (15 to 100 cps) permits both high sensitivity testing and swept-frequency work.

For highest resolution on precise attenuation measurements, you can expand to full scale each 2.5 db portion of any 10 db range with no "blind spots," and the reference is maintained automatically! This expansion gives you 24 calibrated ranges, 0 to 60 db, in 2.5 db steps. The 415D also reads directly in SWR; it is ideal for measuring reflection coefficient and extremely useful as a null indicator for audio-frequency bridges.

Two peak-limited bias currents, readable on the front-panel meter and adjustable ± 10%, prevent accidental bolometer burnout. Other inputs permit operation with crystals and as a null detector.

The 415D has both an ac output for use as a high-gain tuned amplifier and a dc recorder output. High stability with line changes makes the instrument ideal for long-term monitoring. An internal battery pack (optional) makes the 415D completely portable. It is housed in the new hp modular cabinet, which can mount in half of a rack 7" high, combining conveniently in a single rack width with such companion instruments as hp 431 Power Meter.

SPECIFICATIONS

Frequency:	1,000 cps variable 5%, other frequencies between 400 and 1,500 cps available
Sensitivity:	0.1 µv rms at 30 cps bandwidth (lower sensitivity at 0° C)
Noise:	5 db below full scale with 0.1 µv rms sensitivity and minimum bandwidth
Range:	70 db in 10 and 2.5 db steps
Meter Scales:	SWR: 1-4; 3-10; EXPAND 1-1.3. DB: 0-10; EXPAND 0-2.5 Bolo Bias: 4.3 and 8.7 ma indicated.
Accuracy:	±0.1 db/10 db step, maximum cumulative ±0.2 db; ±0.1 db switching from any 10 db step (NORM) to any 2.5 db step (EXPAND) except ±0.05 db switching to 0.0 (EXPAND); ±0.02 db linearity on EXPAND scales
Input:	Bolo: 200 ohms, bias 8.7 or 4.3 ma; Crystal: 200 ohms, 200 K
Output: (one side grounded)	DC: 1 ma into 1,500 ohms maximum AC: 1 v rms in EXPAND, 0.5 v rms in NORM (across 10 K minimum
Power:	115 or 230 v ±10%, 50 to 1,000 cps, 2 watts
Dimensions:	7½" x 6½" x 12½"; 8 lbs., 11 lbs. with battery
Price:	$325.00; $425.00 with battery

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

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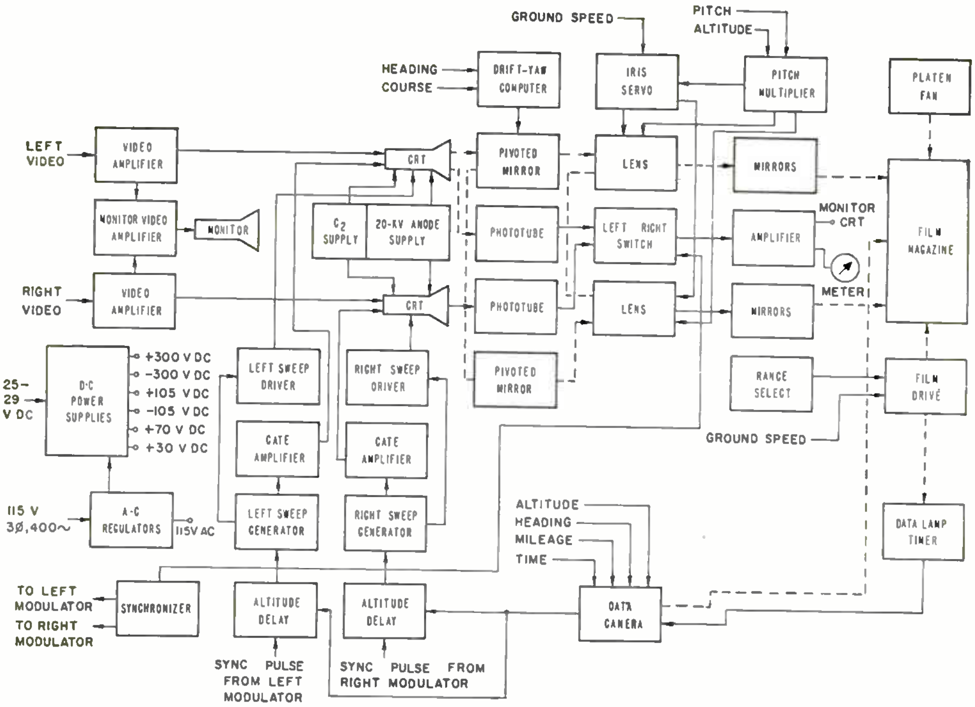


STRIP MAP RECORDER *for side-looking airborne radar, produces continuous photographic record on 9½-in. film. Air Force system also records aircraft heading, course altitude, time and other data*

ficult. The radar beam sweeps the terrain only once, making it difficult for countermeasures equipment to lock on to transmitter output.

Modern side-looking airborne radar usually employs two antennas, looking left and right of the aircraft line of flight. A complete transmitter and receiver system is provided for each antenna. The display and recording system is timed to the radar repetition rate, and also incorporates aircraft flight coordinates in the final map. Antenna angle relative to the ground is adjustable.

Antennas, and transmit-receive equipment, plus servo control systems for antenna angle, are often mounted in a pod and pylon assembly below the aircraft.

TWO GENERIC TYPES Side-looking airborne radar is of two generic types, dubbed "brute force" and synthetic aperture.

The brute force technique involves turning the antenna 90 degrees from the usual position of looking ahead and down in relation to the line of flight, to that of looking to the side and down.

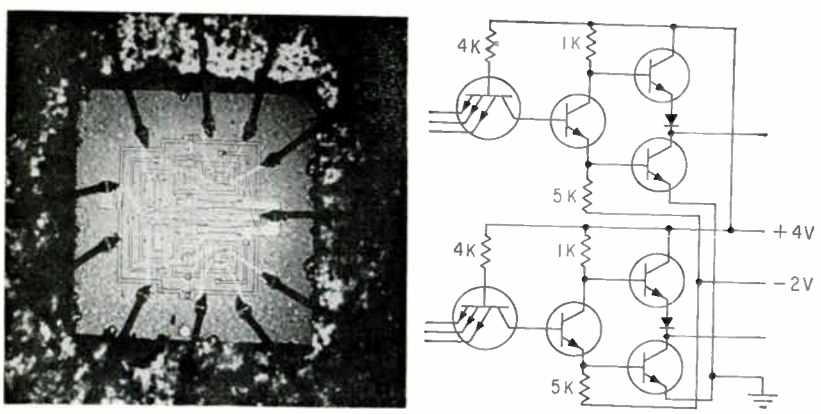
This allows the construction of an antenna of larger aperture than may be obtained in the usual bomb-nav radar format, by providing a longer surface on the fuselage. Large aperture antennas are able to focus the radar beam to a higher degree, producing a narrow bandwidth. A tighter beam provides higher target definition for a given operating frequency and pulse width. Some side-looking radars have antennas 50 feet long, to permit large-aperture designs.

Synthetic aperture techniques take advantage of the antennas' longer physical size and also use special signal processing techniques. This permits reducing the actual physical size of the antenna and at the same time permits synthesizing antennas that are effectively hundreds of feet long.

This is achieved with memory techniques that process aircraft ground speed, course, heading, altitude and other data, and in effect create a series of antennas set end to end, as the aircraft progresses.

Forward motion of the aircraft is used to achieve terrain scanning,

Single-Chip Dual NAND Gate



TYPICAL *of the family of modified transistor-transistor integrated logic blocks introduced last week by Sylvania (see p 8, March 15) is this dual* NAND *gate. Propagation delays are 8 or 11 nsec depending on whether dissipation per stage is 15 or 7 mw. The block shown uses a Darlington-type circuit to increase fan-out to 25 and cascode connection at output to drive 50-pf capacitive loads* while slant range and target direction are obtained in conventional manner.

The signal handling methods used remove all distortion except that of standard radar shadowing, usually obtained with normal physical antennas as well. The resulting strip map that is produced has a seam down the middle, indicating the aircraft's flight path when the mission is carried out by overflying the terrain. Any advanced side-looking radar is of the synthetic array type.

ARMY'S MOHAWK *observation plane, outfitted with side-looking airborne radar (long pod below fuselage) for reconnaissance missions*

PROCESSED IN FLIGHT — One Air Force slar system that processes the signal while in flight produces a 9½-inch-wide map. It has 240-Kw transmitters, with a pulse length of 0.1 microsecond and is tunable in the X-band range.

Receivers for this system are linear-log type, using afc and manual tuning. The antennas used in this slar are roll-stabilized by an electronic servo system to correct for aircraft movement.

Much of the original development work on side-looking radar was done at the University of Michigan, and grew out of Project Michigan carried out there. A side-looking radar was developed by them for the (then) U.S. Army Signal Corps. That system processed the signal on the ground, after the flight was completed (ELECTRONICS, p 40, Nov. 18, 1960). Some of the companies involved now or at one time in the development or production of side-looking radar equipment include: Hughes Aircraft, IBM, General Dynamics, Texas Instruments Incorporated, Raytheon, Goodyear Aircraft, RCA, GE, Bendix, Conductron Corp. and Sperry Gyroscope.

New EDP System Totes Odds

CONSOLE *provides operating controls and selected readout*

Track calculations are speeded by electronic data-processing system

WESTBURY, N. Y. — When the trotters race next June at Roosevelt Raceway here, track odds will be figured and posted by an electronic totalizing system. While electronic computers are now used at some tracks to compute odds, this track will have an all-electronic data collecting and processing system.

The solid-state, digital system was developed by Digitronics; racing savvy was supplied by Roosevelt Raceway. A joint venture by the two firms, named Westbury Electronic Corp., will manufacture and sell the system.

At demonstrations for representatives of tracks from the U.S. and seven other countries, the system was programmed to handle all racing situations, including such an unlikely event as a 15-horse dead heat. Daily-double bets can be accepted up to post time, giving late-arriving fans an extra 10 minutes to get in on the action.

As many as 1,024 ticket selling windows—more than twice what the largest U.S. track now needs—can feed data into the calculating and processing equipment. Each window has a built-in magnetic tape recorder, and each sale is reviewed and certified by the computer in 250 microseconds before the ticket is issued. When a race is over, all accounting is completed in 51 seconds.

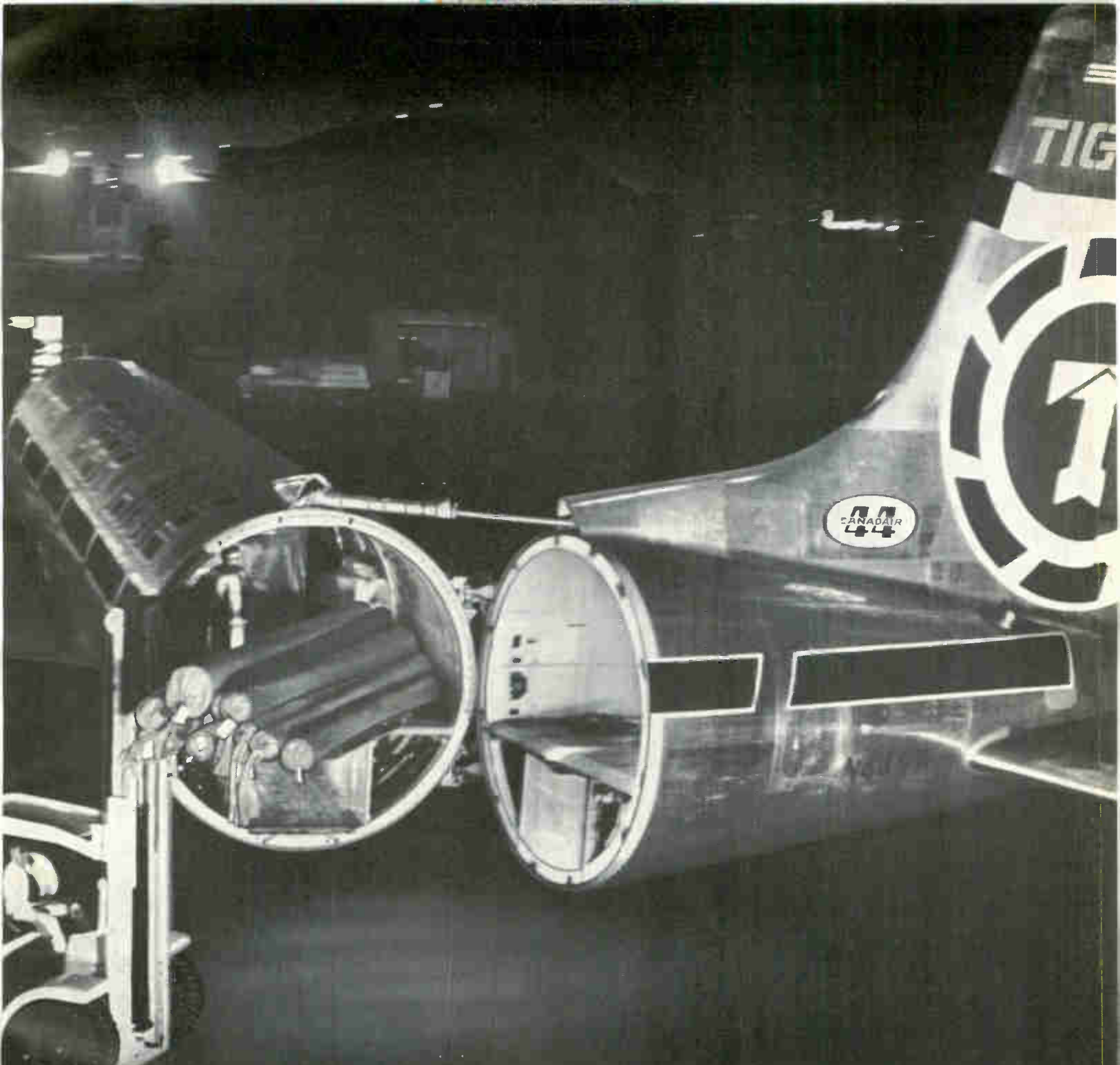
Data-processing equipment includes two general purpose magnetic-core-memory computers and two electronic aggregators for adding up the bets on each horse in each race; readout equipment consists of high-speed printers, punched paper tape, and magnetic tape. System error rate is estimated at 1 in 10^{14} calculations.

Commerce Department Sees New Industry Highs

ALL-TIME records for output, employment and foreign trade in the electronics industry have been predicted for 1963 by the Dept. of Commerce. Factory shipments are expected to reach $8.65 billion in 1963 for combined military and space, commercial and industrial, and consumer products. This would be an increase of 12 percent from the $7.7 billion production of 1962.

Research, development, test and evaluation (RDT&E) is expected to reach $3.2 billion for military and space projects, up from $2.8 billion. This places the total value of production and RDT&E at $11.85 billion, against the $10.5 billion figure issued for 1962. The predicted increase is almost 13 percent.

Exports of U. S. electronic products may reach $975 million during 1963, up from an estimated $765 million in 1962, an increase of over 25 percent. Imports may jump from $275 million to over $340 million in 1963.



Flying carpets? Flying Tigers!

Why does the country's largest manufacturer of special-order custom carpeting regularly ship by air? And why via Flying Tigers?

Because with the Tigers' Swingtail-44's, orders received today can be delivered tomorrow. It sure beats having warehouses all over the country.

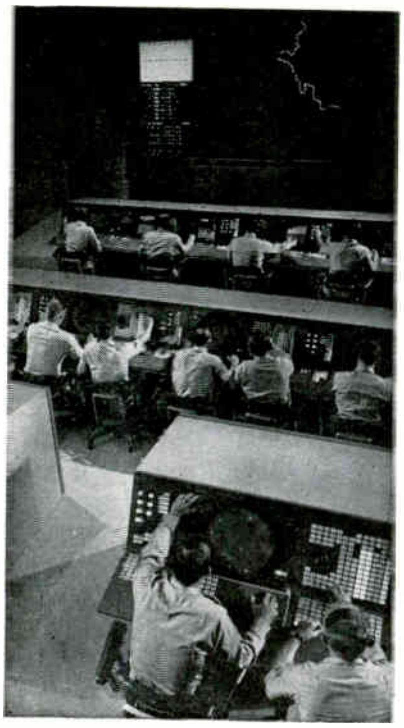
Tigers' expanded fleet of Swingtail-44's means improved schedules, later cut-off times, faster service. The Swingtail-44's open wide, carry a big load—66,000 lbs. That's a lot of cargo space. No chance of your shipment getting left behind. And as for dimensions, whatever the shape, whatever the size, if Tigers' Swingtail-44 can't handle it, nobody can.

Why Flying Tigers for flying carpets? Because they have the greatest all-cargo air lift in the country today. They're fast, they're dependable. They're the Airfreight Specialists.

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

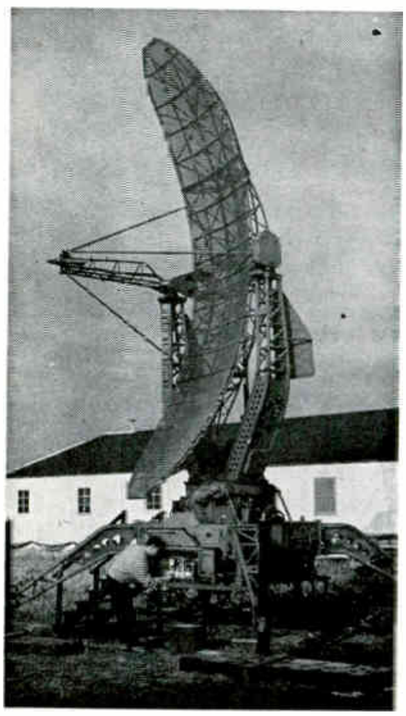
FLYING TIGER LINE
AIR-FREIGHT SPECIALISTS

Air Force Plans Net to Survive Nuclear Attack



AIR-SPACE DETECTION *and tracking data flows automatically to combat operations center like this for the Air Force's 412L Air Weapons Control System, a coordinated network of data acquisition stations, data processing and display centers and weapons bases*

MOBILE TACTICAL *radar used for height measuring, searchlighting targets and locating jamming sources (the AN/MPS-16 nodding-beam) is part of the 412L system*



Here's how generals will communicate if the H-bombs hit

By THOMAS MAGUIRE
New England Editor

HANSCOM AFB, MASS.—A triple mandate implicit in the cold war is reshaping the direction and pace of development in military command and control (C&C) systems.

Emerging and future C&C systems must be:

- Survivable
- Flexible
- Evolutionary

"It must survive under all conditions," says AF Maj. Gen. John B. Bestic, speaking of the first-generation National Military Command System now being designed under Defense Communications Agency direction to assure continuity of command at the presidential and Joint Chiefs of Staff level.

SURVIVABILITY—Other systems now under design or implementation by the Air Force also stress survivability: Pail (Post-Attack Intercontinental Link), in the study stage at Mitre Corp.; 481L Paccs (Post-Attack Command and Control System) for SAC; 416L Buic (Backup Interceptor Control) for Sage (ELECTRONICS, p 28, Apr. 20, 1962); 425L NORAD COC (Combat Operations Center), a hard-core center in the Cheyenne Mountains, Colo.; 477L Nudets (Nuclear Detection and Reporting System), whose sensors, though not survivable, would report nuclear attack data before being destroyed; and Spacecom (USAF Aerospace Communications Complex), whose overall goal is communications between any two command posts in the world by at least two geographically and technically separate routes.

Under study are space-based C&C systems, which "may offer a significant increase in survivability," according to Lt. Gen. James Ferguson, AF deputy chief of staff for research and technology.

One example of the emphasis on survivability is the creation of Buic—a survivable backup system for the vulnerable Sage. In the continuing development of "Baby Sage," the 412L system tagged "Quickdraw," two versions of this overseas-theater tactical air weapons control and warning system are being built, embodying two of the approaches to survivability. The air-transportable version, undergoing tests in North and South Carolina, will be movable when its site becomes vulnerable. It will probably be assigned to Hawaii for Pacific defense against air-breathing threats. The second type is being put into concrete—at hard-core centers in West Germany.

In the proposal stage is Nage (NATO Ground Environment), a Europe-wide air defense system similar to Sage but more sophisticated and presumably less vulnerable. Mitre Corp., the engineering systems advisor for the AF Electronic Systems Division, has an office in Paris for preliminary studies.

FLEXIBILITY—The Administration is giving increased attention to flexibility in C&C systems due to the emphasis on conventional war.

One of the newest C&C systems, tagged 492L, is a special communications net for Strikecom, the AF-Army joint task force for fighting brushfire wars.

Concurrent with the emphasis on flexibility of response is decreased emphasis on automation.

"There never was any question of a machine being in a position to 'push the button'," says an Electronic Systems Division official, "but the automation aspect had been overstressed and it has become necessary to de-emphasize it in order to correct some false notions."

C&C planners agree that the "software" problem — vital for flexibility of response—is more difficult than design or acquisition of C&C hardware. This was a principal thesis at the First Congress on the Information System Sciences, held late last year in Hot Springs, Va. "Software" includes data interpretation techniques; computer programming; extraction of information for sensor data and of intelligence from the information; and design analysis to insure that the system will do what it is supposed to do—permit the commander to make decisions based on the realities of the situation.

EVOLUTIONARY—Both the flexible and the evolutionary requirements of C&C systems are pointed up by the establishment of the Systems Design Laboratory at AF Electronic Systems Division (ESD), where a billion dollars a year is spent on L systems. The Systems Design Laboratory (SDL) now under construction, will be connected to the Sage development sector center at Hanscom Field and will use some of the Sage computer facilities. A Stretch computer, however, will be the heart of the facility.

SDL will simulate, model and test C&C system designs for the future. It is expected to play the major role in system design technology, and will focus the research and experimentation being done by other labs, such as those at System Development Corp., GE, Tempo, SRI and others.

Just as Sage—precursor, pioneer and test bed of modern C&C—taught the dangers of vulnerability and the necessity for survivability provisions, so Sage also taught the need for evolutionary development of C&C systems: 'Do not try to optimize a system, but fix it so you can change it quickly.'

"We have to make sure the user's capability grows with the system," it was pointed out recently by C. A. Zraket of the Mitre Corp. and ESD's Harold Wright. Instead of being built in isolation, a system would ideally evolve with the capabilities of the user—making sure he is prepared to use the system when it is ready.

TOP LEVEL C&C—The Systems Design Laboratory at Hanscom Field will be the principal instrumentality for assuring this evolutionary development. It will simulate and model systems before they are built, testing their compatibility with other systems and integrating them into the C&C pyramid whose apex is the White House-level National Military Command System (Nmcs).

Today's Nmcs is both manned and vulnerable. "We have achieved a high degree of survivability in our major weapons systems, which we do not enjoy in our command and control structure," Gen. Bestic recently told a National Security Industrial Association meeting at Hanscom Field.

Bestic is deputy director of the Defense Communications Agency, to which DOD has assigned the job of designing the first-generation Nmcs. Hopefully, it will be operational in 1966. Various facets have been assigned to the three services by DCA.

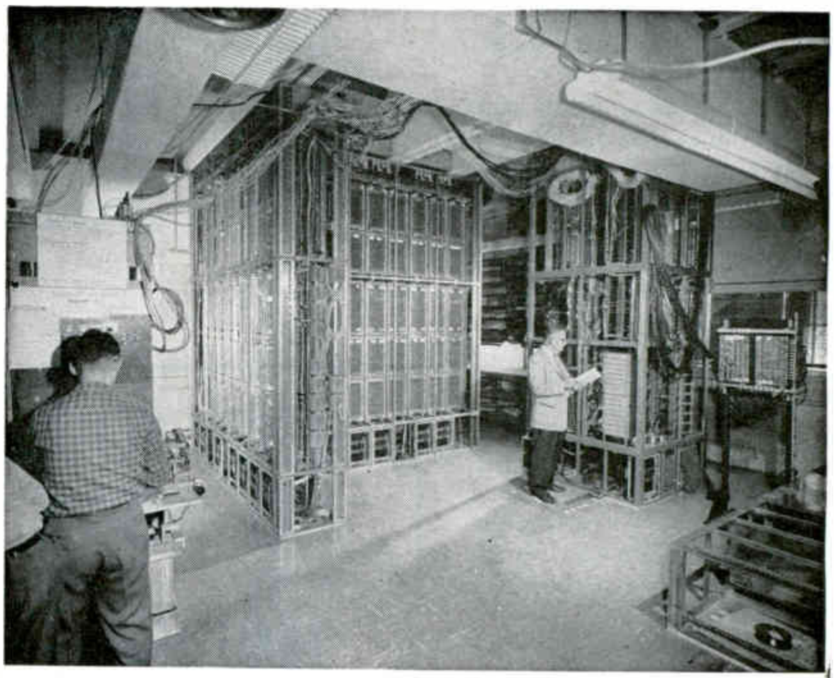
Meanwhile, the existing system is being improved through redundancy and mobility. The heavy cruiser USS Northampton has been equipped with special communications, data processing and display equipment required to make it function as a command center. To provide alternate centers aloft, KC-135 Turbojet tankers have been similarly equipped and are in service.

"Other quick-fix improvements will be pursued even as we develop the design for what we call the first-generation Nmcs," says Bestic. Advances in data processing, and display, data transmission and human engineering will figure prominently in the design.

Responsibility of the Nmcs is comprehensive. It must provide complete and current status of U.S. and allied forces; complete and current status of neutral, potentially hostile and hostile forces; complete and current status of U.S. weapons; accurate and current evaluations of worldwide politico-military situations as they influence, or may influence, U.S. response," Bestic said.

And finally: "It must survive under all conditions."

$4-Million Worth of Computer



ILLIAC II, *successor to the University of Illinois' recently retired Illiac computer is expected to go into general use in June. University says that it competes with Stretch in speed. Part of the $4-million cost was provided by AEC, Navy and IBM. Under construction since 1958, computer will contain 40,000 transistors and 60,000 diodes*

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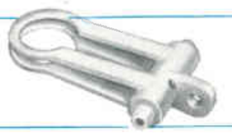
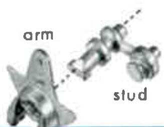
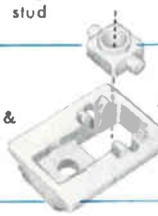
THIS!

GRC customer	part description (plus end product use)		material & processes used	how GRC provides **HIGHER VALUE**
STEWART WARNER	Coil Carrier for Electric Speedometer		Automatically molded in Nylon	Precise, intricate 1-pc. molding 1) retains coil, dynamic balance pin, pivot shaft, 2) provides mount for counter-balance weight, **assures uniform multi-function part, simpler assembly.**
CLAROSTAT	Mated Rocker Arm & Stud for Volume Control		Automatically die cast in Zinc Alloy	Pre-GRC: 2 screw machine parts + stamped arm + forming operation. GRC die casts 2 studs as 1 part; integral lug of stud mates with locking slot in arm. **Lowers assembly cost and inventory, improves product performance.**
RONSON	Mated Inner Cutter Bearing & Trunion for Electric Razor		Automatically molded in Delrin	Precise snap-fit of trunion & inner cutter bearing—fit held to 0.001"—assures bind-free rotation during 14,400 cpm reciprocating motion of bearing (cutter bar attached to it). Design allows replacement of worn cutter head only, not entire shaving head. **Makes competitive product advantage possible.**
DICTAPHONE	Taper Pin Receptacles for Dictating Machine		Automatically die cast in Zinc Alloy	Quickly, efficiently establishes electrical contact, eliminates soldering assembly step, provides easy connect and disconnect. **Simplifies field service, speeds assembly.**
LIONEL	Coupler for Model Railroad Train		Automatically molded in Delrin	Pre-GRC: spring + casting + assembly. GRC molding with integral leaf spring design costs less, eliminates extra assembly, simplifies major coupling problem. **Reduces parts, assembly, inventory costs, improves performance.**
IBM	Plug Nose for Data Processing Machine		Automatically die cast in Zinc Alloy	Design with GRC plug nose makes patch cord removal from program board easy, yet resists accidental pull-out; allows automatic assembly of patch cord (former stamped part did not). **Automates assembly, improves in-use reliability.**

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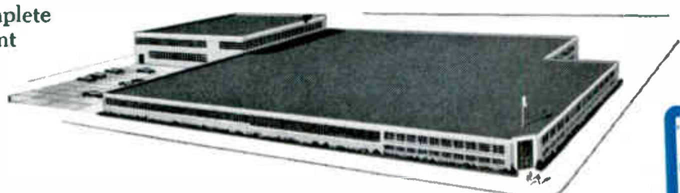

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BEFORE RELAY I *failed, Associated Press used the satellite to transmit this news photograph of a woman flyer simultaneously to London, Paris and Rome*

Relay Transmitting Again

One satellite is cured but Telstar and Syncon still are not operating

ALTHOUGH THE U.S. has three active communications satellites in orbit, none of them were operating early last week. The previously reported failures of Telstar and Syncom left only Relay working, and that went off the air from March 9 to 13.

An abnormal power drain resulted when a transistor switch in Relay's No. 1 transponder could not be turned off. To prevent damage from overheating, the satellite was deactivated. After the batteries recharged, the switch was closed. This permitted the use of transponder No. 2, which has been used for more than 500 communications experiments.

Telemetry data began coming in again from the satellite at 10 p.m. March 13.

TELSTAR — Experiments continued last week at Bell Telephone Laboratories to try to get AT&T's Telstar satellite functioning again. Scientists are transmitting various coded command signals in attempt to reactivate Telstar, according to Bell Labs. Transistor damage from high radiation levels reportedly caused Telstar to misinterpret one of the coded signals and command the satellite to stop transmitting.

SYNCOM—Hope that Syncom may yet be put into operating order still exists. Cause of the failure has, thus far, been attributed to a malfunction in the main power supply.

Although the orbit was better than expected, NASA believes that Syncom may not have achieved correct attitude preventing the vehicle from acting on ground commands. Syncom is now drifting at a 2.8-degree eastward rate and attempts are being made to command the satellite.

Syncom is providing the first flight test for Goddard Space Flight Center's range and range rate tracking method. The system enables ground stations to predict the satellite's position, so it can be optically located and photographed. The system will probably be used for all satellites in the orbiting observatory series and it is likely all NASA ground stations will be modified for it.

Microwaves Study Weather

MILLION-DOLLAR microwave investigation of earth's lower atmosphere will begin this spring as a joint project by University of Wisconsin meteorologists and Collins electrical engineers.

One-degree microwave beams will be pulsed simultaneously from 30-foot radar-type antennas at Arlington Farms and Collins at Cedar Rapids—about 140 miles away.

Scattered signals from their "common volume" intersection—picked up by antennas in pauses between pulses—will total about one ten-billionth of the transmitted signal, according to Verner Suomi, Wisconsin meteorology professor. He said transmission frequency and height of the "common volume" can be varied.

Characteristics of the scattered microwaves related to moisture distribution, thermal and turbulence phenomena and other atmospheric properties will be recorded and analyzed over two years of investigations.

Probing the atmosphere electronically to provide basic meteorologic and electronic data could ultimately have far-reaching practical applications, Suomi said.

Airports of the future could use such a setup for continuous monitoring flight conditions over their fields. Flicker and fade-out of tv and radio signals might be avoided by automatically adjusting the transmitting frequency according to atmospheric conditions reported by scatter information, said William Birkemeier, Wisconsin associate professor of electrical engineering.

The National Science Foundation granted Wisconsin the first part of an expected $250,000 for the project last month. Collins is providing additional equipment valued at $750,000.

King-Sized Radome

RADOME *weighing 102 tons is built around 125-ft-long antenna of FPS-35 continental air defense radar in Oregon. Object, says Sperry Gyroscope, is to permit radar to keep operating in 150-mph winds, which it cannot now do*

CIRCLE 33 ON READER SERVICE CARD

CIRCLE 34 ON READER SERVICE CARD→

Be fussy

Two things determine whether or not a particular printed circuit connector is "right" for your application:

1. How the printed circuit board mates with the connector, and

2. How the connector connects to the rest of the system.

Take mating, for example. Besides having the correct number of contacts, a printed circuit connector must hold the board securely whether the board happens to fall at the high or low end of thickness tolerances.

IT TAKES THREE

These considerations convinced Amphenol engineers that no single contact design could satisfy the requirements of a wide range of applications. So they designed three contacts that will.

One, used in Prin-Cir* connectors, looks a lot like a tuning fork with lips. The circle lip design makes contact overstressing or "setting" impossible—even after repeated insertions. The contact's long spring base also enables it to accommodate boards that range in thickness from .055" to .073", while doing an excellent "wiping" job.

EASY DOES IT

But not every application requires the Prin-Cir "bite." For this reason, Amphenol engineers designed connectors with ribbon contacts that mate with a gradual wedge-like force. In blind mating applications, gradual mating makes the feeling of *correct* mating unmistakable. (Just the thing when your equipment may eventually be maintained by less-skilled and less-concerned personnel.) Ribbon contact wedge action also makes it possible for connectors using these contacts to accept the same wide range (.055" to .073") of board thicknesses as do Prin-Cir connectors.

Finally, advances in micro-miniaturization (like Amphenol-Borg's Intercon® pre-fabricated circuitry) meant that tinier-than-ever-before connectors were needed. Amphenol's answer was the Micro-Min® receptacle and printed circuit board adapter. Micro-Min contacts are actually tiny springs of beryllium copper wire, formed in a precisely designed arc to assure firm circuit board retention. This unique design makes it possible to space contacts on .050" centers and crowd 19 connections into a little more than an inch of space.

TERMINATIONS COUNT, TOO

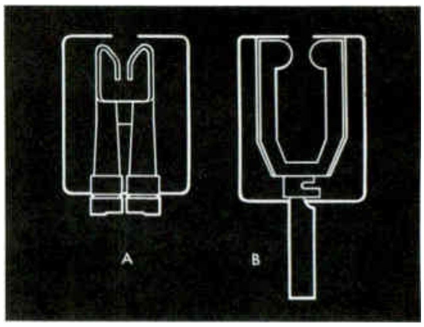
"How to connect connectors to the rest of the system" also merits a good deal of consideration. In some cases, hand soldered terminations will do just fine. In others, higher volume requirements call for high production rate methods like dip soldering and wire-wrapping. Some engineers prefer taper pin terminations.

Our printed circuit connectors are available with contact tails designed for each of these termination methods. In addition, adapters are available for use in connecting printed circuit boards at right angles to each other or in modular arrangements. We make printed circuit connectors with hermetically sealed contacts — still others with coaxial contacts.

Take your choice.

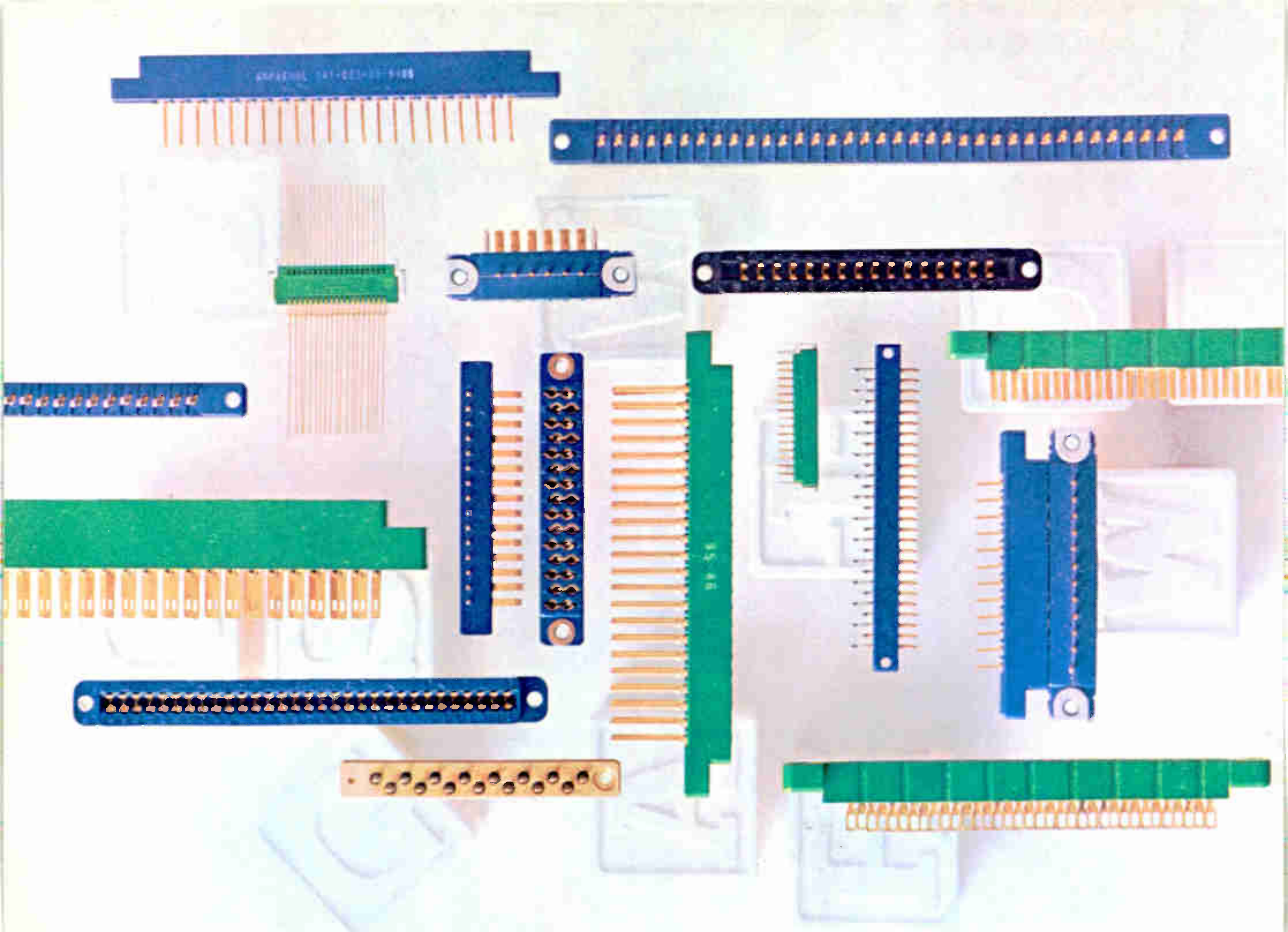
Any Amphenol Sales Engineer or authorized Amphenol Industrial Distributor will be happy to discuss printed circuit connectors (ours) with you. Or, if you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois.

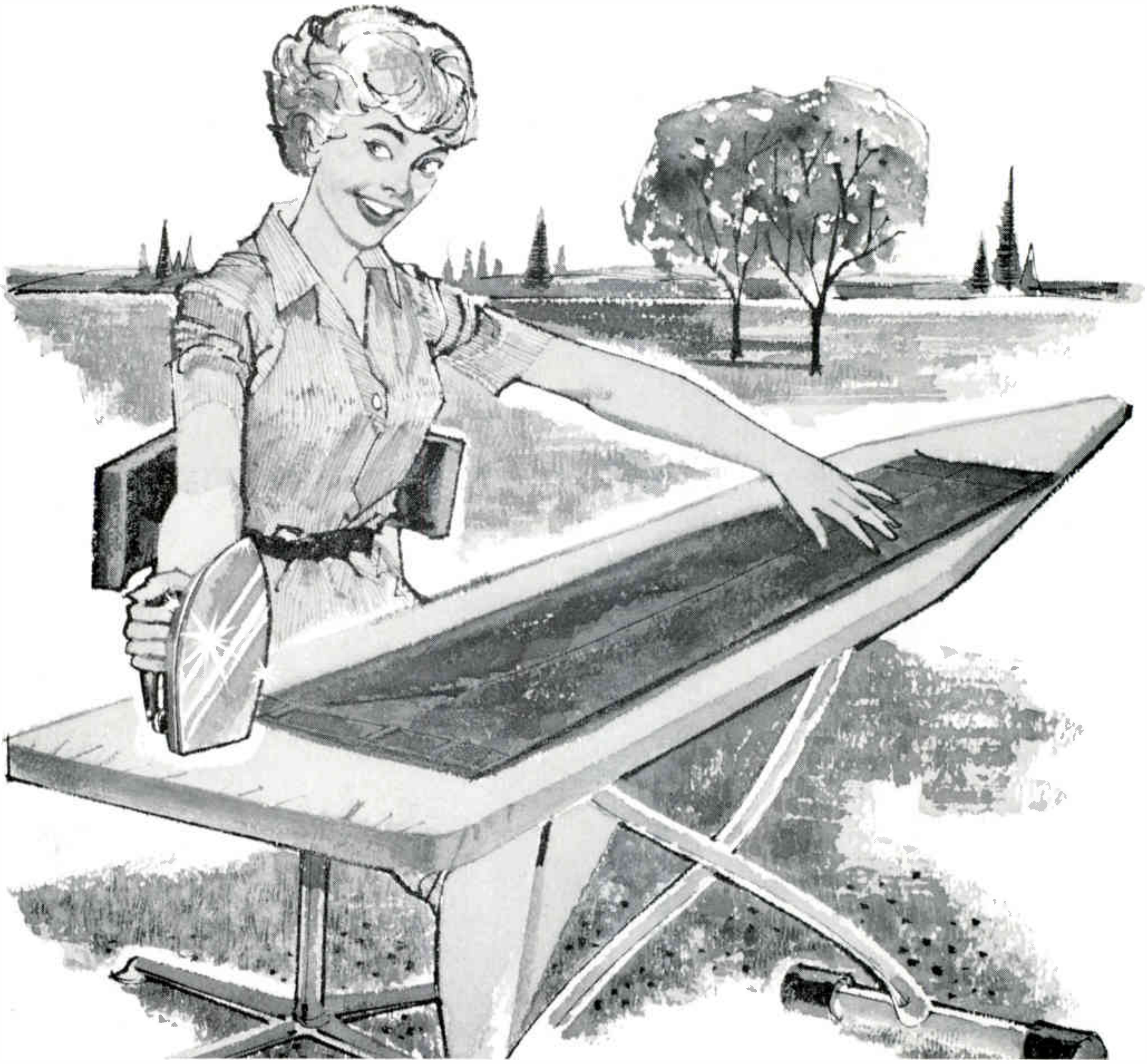
*T.M. Amphenol-Borg Electronics Corp.



Wedging action of Amphenol ribbon-type (A) and long spring base of Amphenol Prin-Cir connectors (B) assure firm printed circuit board retention, whether board happens to fall at low (.055") or high (.073") end of thickness tolerance.

AMPHENOL **Connector Division** / Amphenol-Borg Electronics Corporation





What won't you think of next?

Maybe the picture of Mom ironing Dad's trousers while sunning herself may be a bit far-fetched. A portable iron (battery-powered?) may be even more so. Probably impractical.

Our point is this—your present design problem may seem just as impractical, just as the drill, shaver, mixer and other cordless products did a few years ago. But Gould-National research engineers developed a package of concentrated power using NICAD® Hermetically Sealed Rechargeable Cells that helped to make these products a reality

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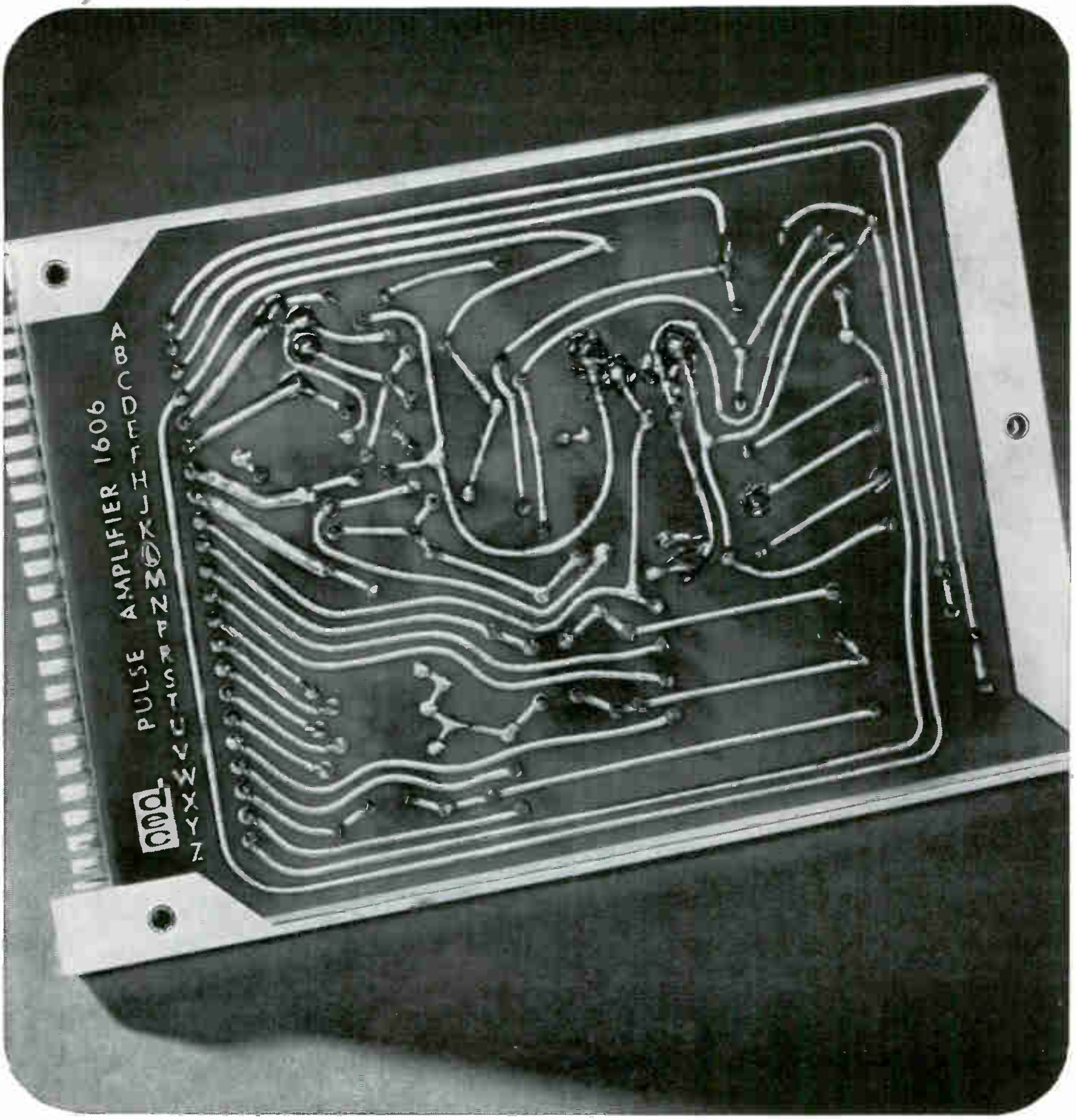

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MEETINGS AHEAD

EUROPEAN ELECTRONICS MARKET, EIA; Statler Hilton, Washington, D. C. **March 19-22.**

INSTITUTE OF PRINTED CIRCUITS MEETING, IPC; Barbizon-Plaza Hotel, New York City, **March 25-27.**

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

ELECTRON BEAM SYMPOSIUM, Alloyd Electronics Corp.; Somerset Hotel, Boston, Mass. **March 28-29.**

BROADCAST ENGINEERING CONFERENCE, National Association of Broadcasters; Conrad Hilton Hotel, Chicago, **March 31-April 3.**

RADIOISOTOPE CONFERENCE, Oak Ridge National Laboratory, et al; Gatlinburg, Tenn., **April 1-3.**

PROTECTIVE RELAY ENGINEERS CONFERENCE, A & M College of Texas; at Texas A & M, College Station, Texas, **April 8-10.**

ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS SYMPOSIUM, IEEE, IAS, University of California; at UC, Berkeley, Calif., **April 10-11.**

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

CLEVELAND ELECTRONICS CONFERENCE, IEEE, Case Institute, Western Reserve University, ISA; Hotel Sheraton, Cleveland, O., **April 16-18.**

OPTICAL MASERS SYMPOSIUM, IEEE, American Optical Society, Armed Services, et al; Waldorf Astoria Hotel, New York City, **April 16-18.**

INTERNATIONAL NONLINEAR MAGNETICS CONFERENCE, IEEE; Shoreham Hotel, Washington, D. C., **April 17-19.**

SOUTHWESTERN IEEE CONFERENCE & ELECTRONICS SHOW, IEEE (Region 5); Dallas Memorial Auditorium, Dallas, Texas, **April 17-19.**

BIO-MEDICAL ENGINEERING SYMPOSIUM, IEEE, et al; Del Webb's Ocean House, San Diego, Calif., **April 22-24.**

NATIONAL ELECTROMAGNETIC RELAY CONFERENCE; Oklahoma State University; OSU, Stillwater, Okla., **April 23-25.**

ADVANCE REPORT

RELIABILITY & QUALITY CONTROL NATIONAL SYMPOSIUM, IEEE-PTG: *Statler Hilton Hotel, Washington, D. C., Jan. 7-9, 1964. May 15 is deadline for submitting 10 copies of 800-word abstract and brief biographys to: Dr. L. S. Gephart, Lockheed Missiles and Space Co., Department 64-01, Building 104, Sunnyvale, California. Papers must not have been presented at other national society meetings. However, papers given at local meetings are acceptable.*

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Measuring just ⅜″ x ⅜″ x 13/64″, these TRIMPOT® potentiometers embody the performance and features of units occupying twice the volume. The unique central mounting hole makes this improvement possible—in both wirewound and RESISTON carbon versions. It permits the same size resistance elements as those used in ½″-square potentiometers and the same high power ratings—1W @ 70°C for wirewound and 0.50W @ 50°C for RESISTON carbon. Both models offer 25-turn screwdriver adjustment with positive end-stops. A special clutch feature eliminates the possibility of damage from forced adjustment.

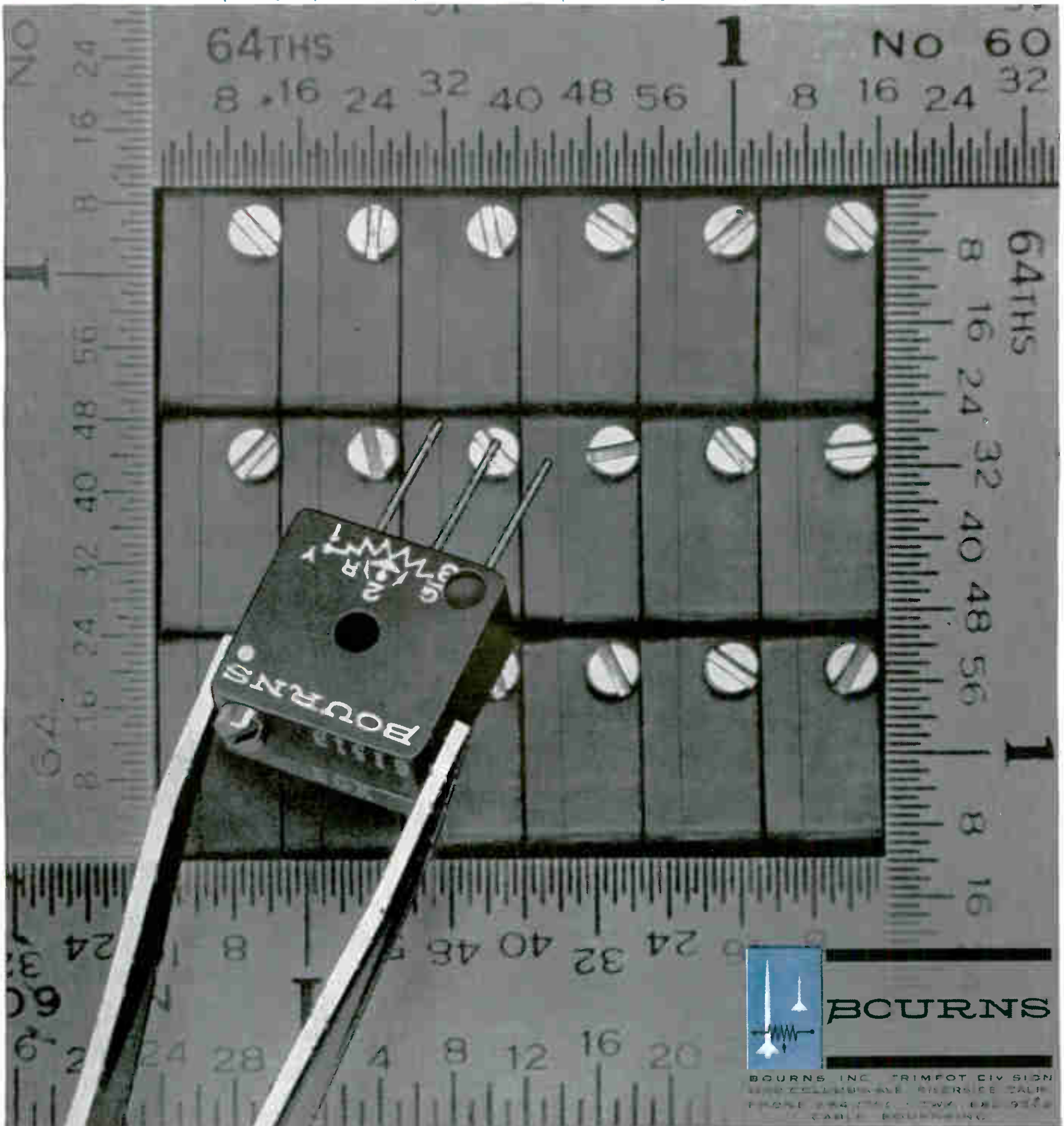
The infinite-resolution RESISTON carbon models extend the resistance range of Bourns ⅜″-square potentiometers to 1 megohm, and offer a maximum temperature coefficient of just ±0.03%/°C from −65° to +150°C.

Both models are the same size; you can mount 14 wirewound or 14 carbon units in one square inch of circuit-board space. The procedure is simple and sure. Stacking tabs on the cases ensure proper alignment and prevent rotation. A sealed case contributes to the reliability of these units, which meet or exceed applicable Mil Specs.

	MODEL 3280 (wirewound)	MODEL 3281 (RESISTON® carbon)
Max. Oper. Temp.:	175°C	150°C
Power Rating:	1W @ 70°C; 0.5W @ 125°C	0.50 @ 50°C; 0.25W @ 100°C
Resistances:	100Ω to 50K	20K to 1 Meg.
Humidity:	MIL-STD-202B, Meth 106 (cycling)	

ACTUAL SIZE

Units are available immediately with printed circuit pins (from either narrow or flat side of case) or flexible leads. Write for complete data.



Manufacturer: TRIMPOT® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, Calif.; Ames, Iowa; and Toronto, Canada

SEE BOURNS PRODUCTS IN BOOTHS 1429-1431 AT THE IEEE SHOW

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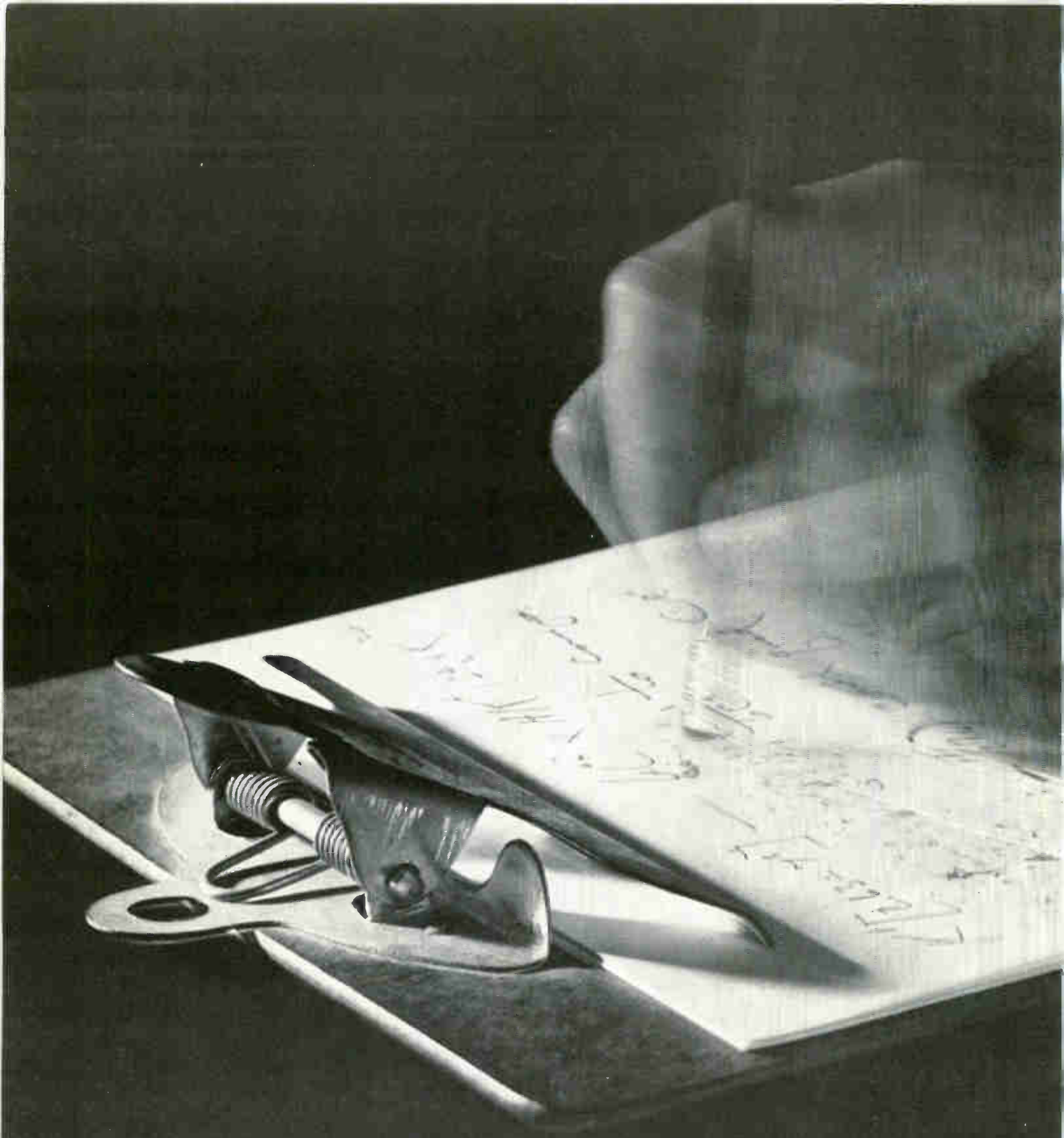

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PROGRESS IN MICROWAVE COMMUNICATIONS

Advances in components design have brought far-reaching changes in circuit techniques employed in microwave link repeaters but, for broadband response, the travelling wave tube amplifier maintains its position supreme. This does not imply complacency on the part of the tube manufacturer. On the contrary, continuous efforts are made to produce tubes of better and better performance—improved gain, lower noise factor, higher synchronous saturated output level and reduced phase modulation distortion. During the last decade, STC have maintained a leading position in this field.

The travelling wave tube cannot be considered in isolation. Its correct performance is very much dependent upon its mount which contains a magnetic focusing arrangement (including devices for trimming the focus of individual tubes) as well as arrangements for coupling the input and output signal to and from the tube helix together with the requisite matching contrivance.

Whilst the mode of operation of the travelling wave tube does not permit much change in the overall length of the mount, economy has been achieved by replacing power consuming solenoids by periodically reversed permanent magnets; forced air systems by convector coolers, and focus-trim deflector coils by mechanical fine adjusting screws.

STC designs are based on a vast experience of manufacturing components for microwave equipment in use in major communication systems installed in 19 countries of the world.

STC TRAVELLING WAVE TUBES

Announcing another NEW Type

abridged data

Tube Type	Mount Type	RF Connexion (W.G. Flange)	Frequency Range (Gc/s)	Sync. Sat. Output (W)	Gain (dB)	Noise Factor (dB)
W5/1G	495-LVA-105B	UG344/U				
	495-LVA-105C	CMR137	5·85 to 7·2	8 to 11	35 to 39	26
	495-LVA-105D	UG344/U				
W5/2G	495-LVA-107B	UG344/U	5·8 to 6·6	16	37 to 41	27
W7/3G	495-LVA-104	12A*	3·6 to 4·2	8 to 10	28	27
W7/4G	495-LVA-101A	12A*	3·6 to 4·2	10	42	27

*Transition pieces to WR229 available

Write for brochure MS/113 "STC Microwave Tubes"

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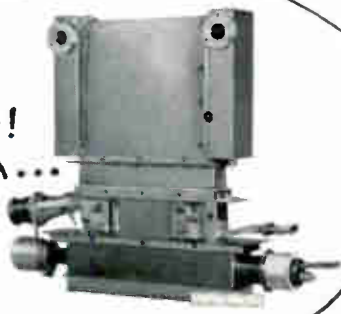

A **WHAT?**

AN **MBK!** IT'S GENERAL ELECTRIC'S **MULTIPLE BEAM KLYSTRON,** TYPE ZM-6601. THIS NEW TUBE'S conservatively designed individual beams, multiplied in a phase-locked multiple-beam structure, provide high RF power output at low thermal densities. And G.E. is now offering 60 day delivery!

Electrical and thermal stability of the ZM-6601 is typical of tubes operating at **one-tenth the power level.** The MBK requires only 12.8 KV beam voltage, eliminating extra size and weight encountered in paralleling conventional "high power" klystron tubes. It's unique among factory-built klystrons.

Here are some of its vital statistics . . .

Frequency	8.3–8.5 Gc
Tuning Range	80 mc
Power Output	50 KW CW
Typical Voltage	12.8 KV
Nominal Gain	45 db
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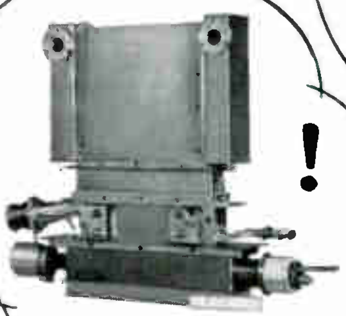

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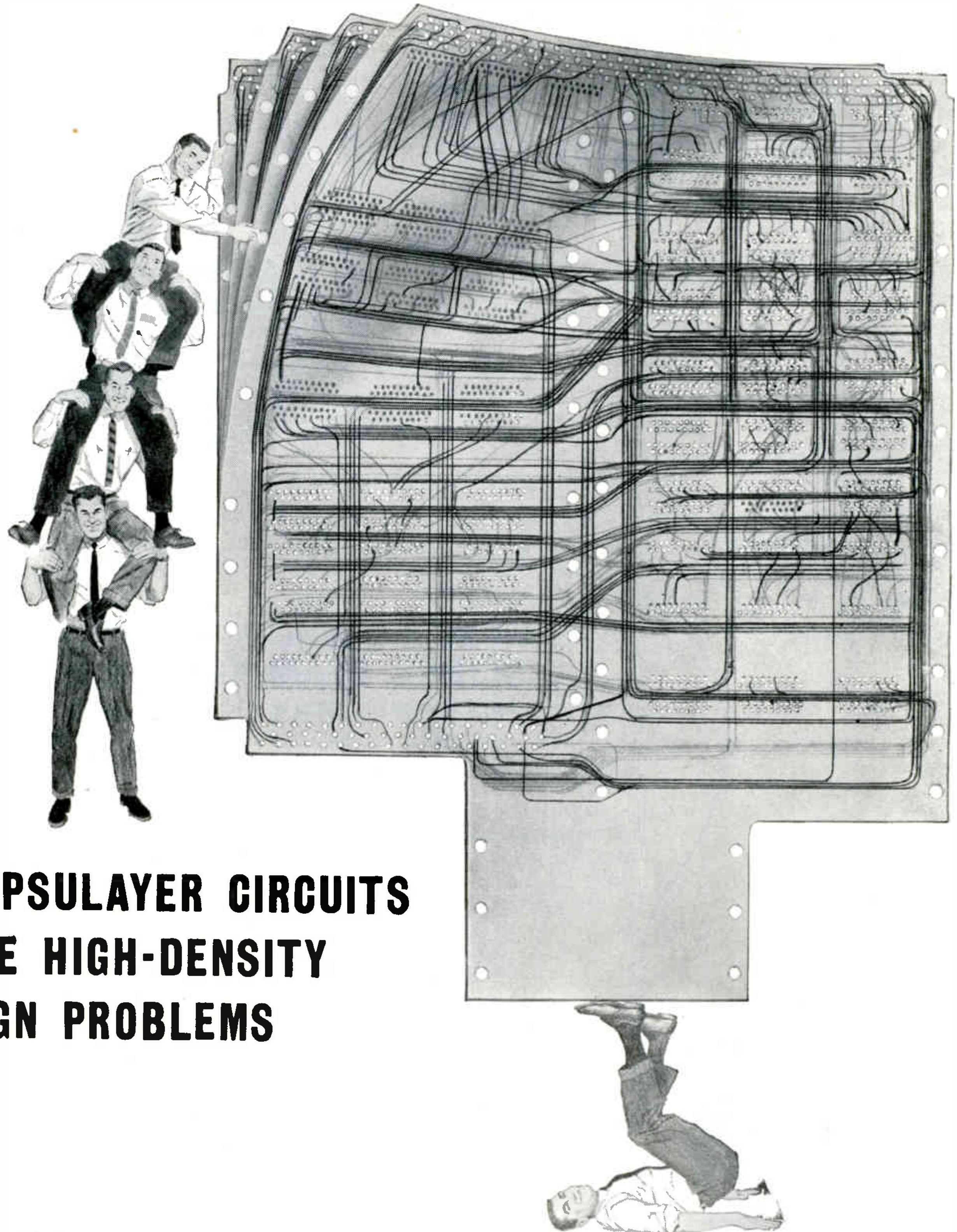

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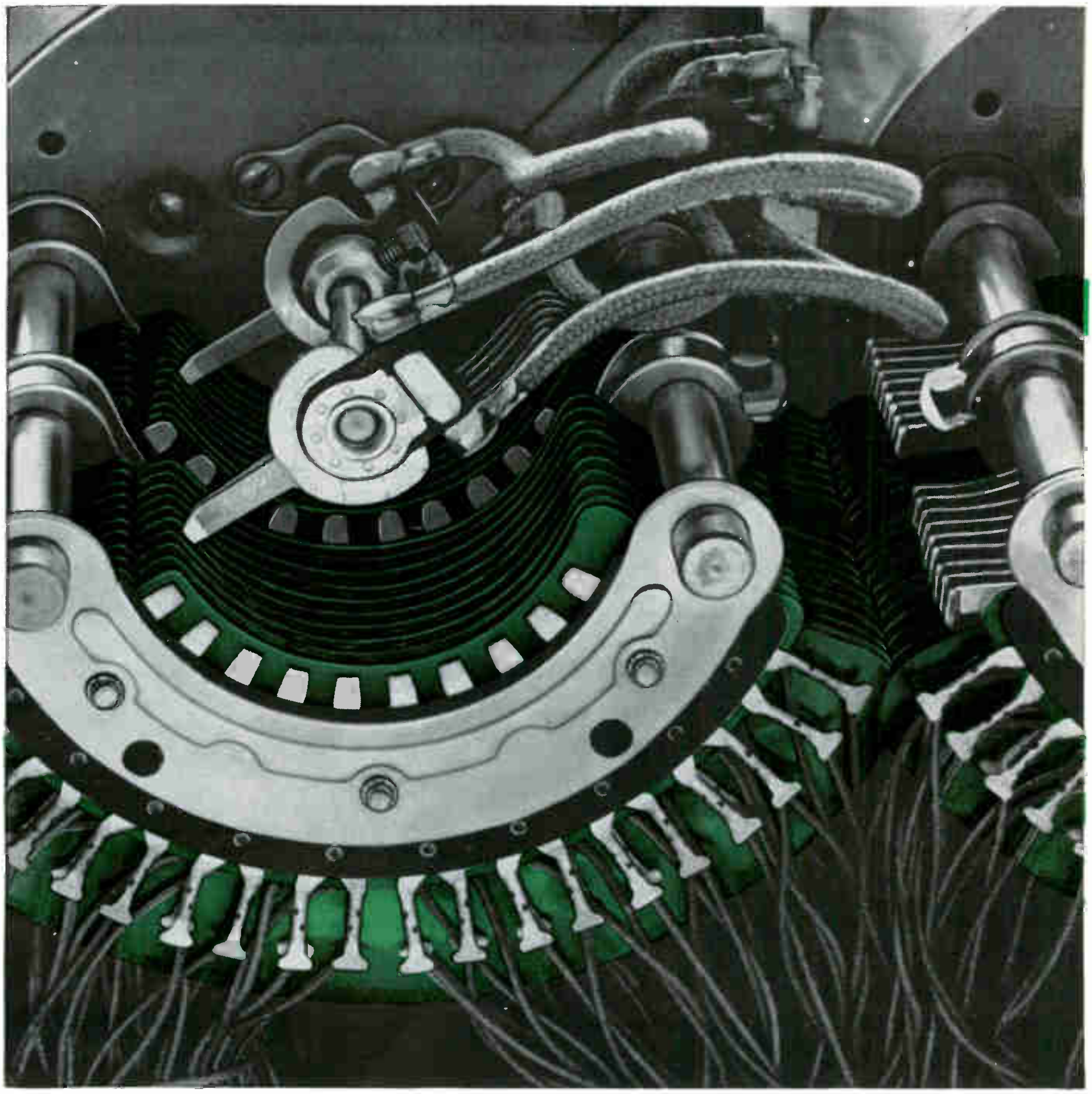

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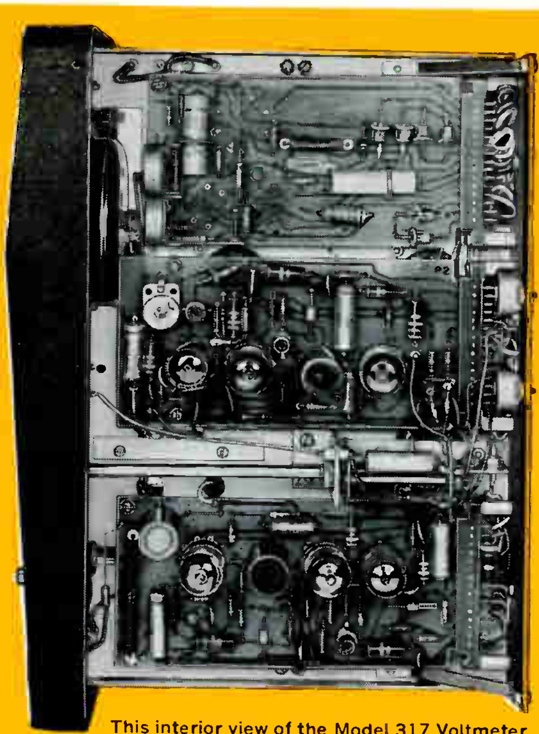

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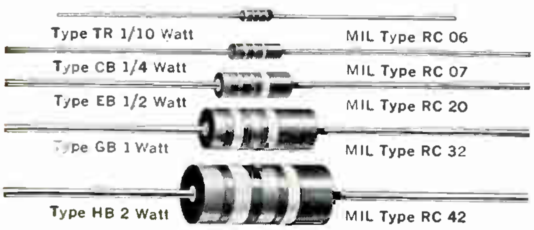

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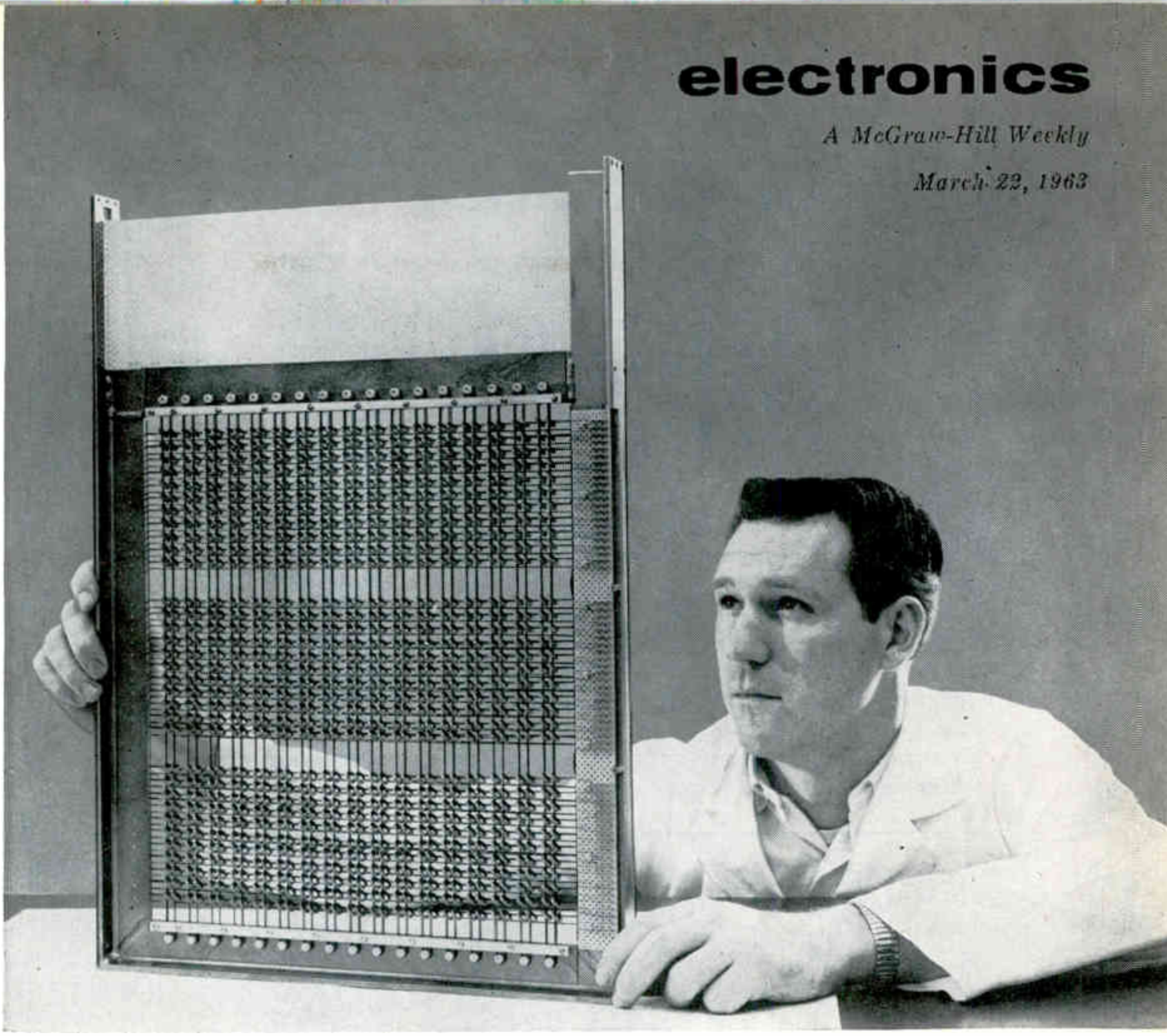

ANALOG MEMORY *plane with 561 second-harmonic magnetic weights*

COMPONENTS THAT LEARN AND HOW TO USE THEM

By HAROLD S. CRAFTS, **Research Engineer, Stanford Research Institute, Menlo Park, California**

Five components suitable for use in adaptive systems are detailed along with their application to complete adaptive systems

ADAPTIVE SYSTEMS can be trained to perform specific tasks by being shown sample problems and solutions. In addition, such systems can generalize on limited training experiences in solving related, but previously unseen, problems. The ability of adaptive systems to tolerate either malfunctioning components or input noise makes them suited to solve problems such as pattern recognition.

These properties have stimulated the search for suitable adaptive components. Many phenomena offer the potential of variable gain with memory. At present, however, the required long-term gain stability limits consideration to phenomena involving atomic translation or rotation. Purely electronic phenomena, with the possible exception of cryogenic devices, are excluded.

Five components providing variable gain with memory are discussed in this article, together with applications of these components. The memory mechanism used in the first of these devices is the translation of atoms in an electrolytic plating system; the remaining four devices exploit magnetic phenomena.

MEMISTOR — The nonmagnetic component considered here is called the memistor (for resistor with memory).[1] It consists of a resistive substrate immersed in an electrolyte. A d-c adapt signal removes copper from an anode and deposits it by electroplating upon the substrate, thus lowering the resistance of the substrate. Reversal of the adapt current removes the copper from the substrate and returns it to the anode, raising the resistance of the substrate to its original value. The basic structure is shown in Fig. 1A. Resistance of the substrate is sensed with a small alternating current, the voltage drop being proportional to the resistance. The sensing current must be small enough so that the a-c output voltage does not interfere with the plating reaction. This limits the output to about 100 millivolts, but low impedance levels contribute to a good signal-to-noise ratio. Components whose resistance is continuously adjustable over 100:1 range with a drift in gain stability of less than 1 percent per day have been made. An adapt current of 10.2 milliampere will change the resistance of the substrate through its dynamic range in about ten seconds.

There are two basic types of magnetic variable gain components. In both types, the gain is in proportion to the net remanent flux in the cores. The difference arises in the method of sensing this flux.

MULTIAPERTURE-DEVICE — The diagram of a multiaperture device (MAD) variable gain adaptive component is shown in Fig. 1B.[2] In this device, flux can be switched around the small apertures without disturbing the flux around the main aperture. Thus, the output may be sensed by al-

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SYSTEMS THAT LEARN BY DOING

Adaptive or learning systems modify their own structure to get a certain performance based upon past experience. If the output of the system agrees with the desired output, the values of the variable gains are not changed. If the output does not agree, the variable gains are altered so that it does. In adaptive terminology, these gains are called weights, and they may have positive or negative values. The weight setting determines how much effect that input will have upon the output.

One application of an adaptive system is in high-speed aircraft control systems where the control response time varies over a wide range depending upon altitude. Outside the field of adaptive systems, variable gain components may find use in the analog storage of information. But adaptive systems remain the principal use for these components, since no other component can perform this function at a price that can be afforded. Presently, weights cost about a dollar as compared to 10 dollars a year ago. At the rate that adaptive systems are being pushed, prices of weights will have to be reduced at least another order of magnitude

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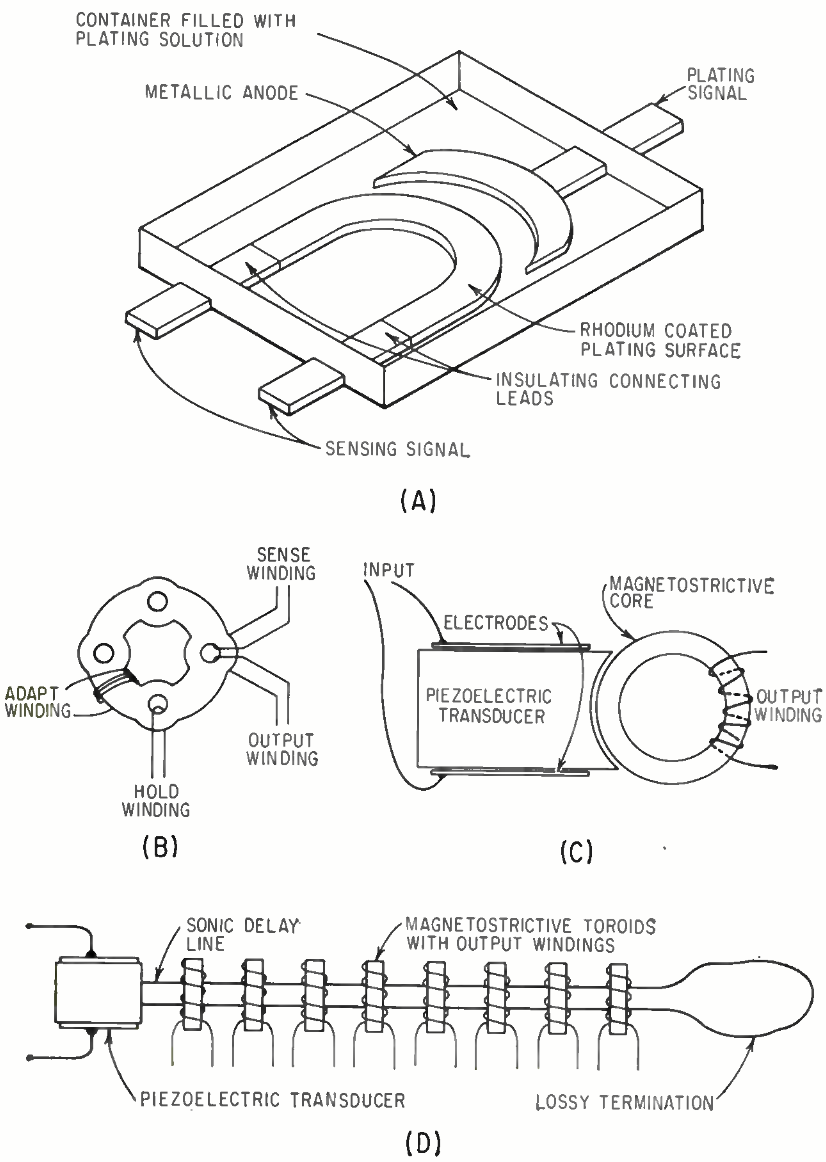
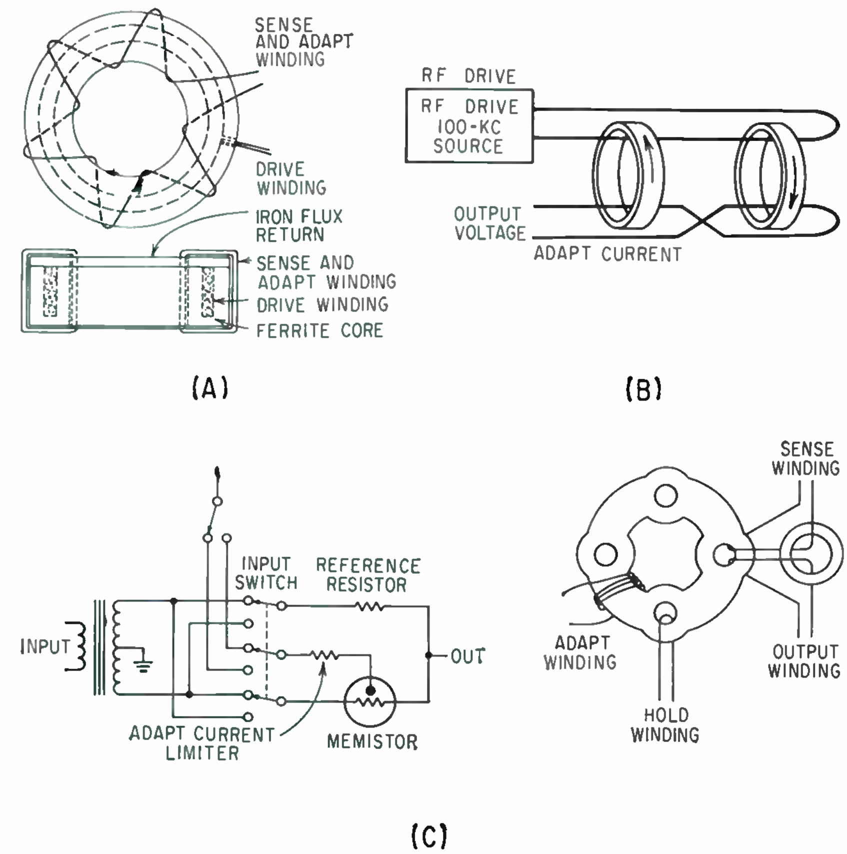


VARIABLE GAIN *components include a nonmagnetic component, the memistor (A), a multiple aperture device (MAD) variable gain component (B), a magnetostrictive device (C), and a magnetostrictive device using a sonic delay line (D)—Fig. 1* ternately switching the flux around one of the small apertures. However, the amount of flux being switched by the sense current is dependent upon the amount of flux that has been switched around the main aperture. By pulsing the adapt winding, flux is switched in small increments around the main aperture. This changes the amount of flux that can be switched around the small aperture by the sense current, and hence changes the output voltage.

The sense winding on the multiaperture device switches flux irreversibly, producing high output levels but requires high drive power. A core is said to be switched reversibly if the remanent state is not affected by the switching current. If the current level is raised until the remanent state is disturbed, the switching becomes irreversible. Although the switching is irreversible, the sensing is nondestructive, since the amount of flux switched is controlled by the main aperture magnetic condition. In other magnetic variable-gain components, the sensing current switches flux reversibly, reducing the required drive power and the output level.



TWO FORMS *of magnetic integrators. In (A), the flux level is altered by pulsing the output winding. In the second harmonic generator (B), the flux level is altered by passing d-c through the output winding. Bridge arrangements (C) for operation of the memistor or MAD—Fig. 2*

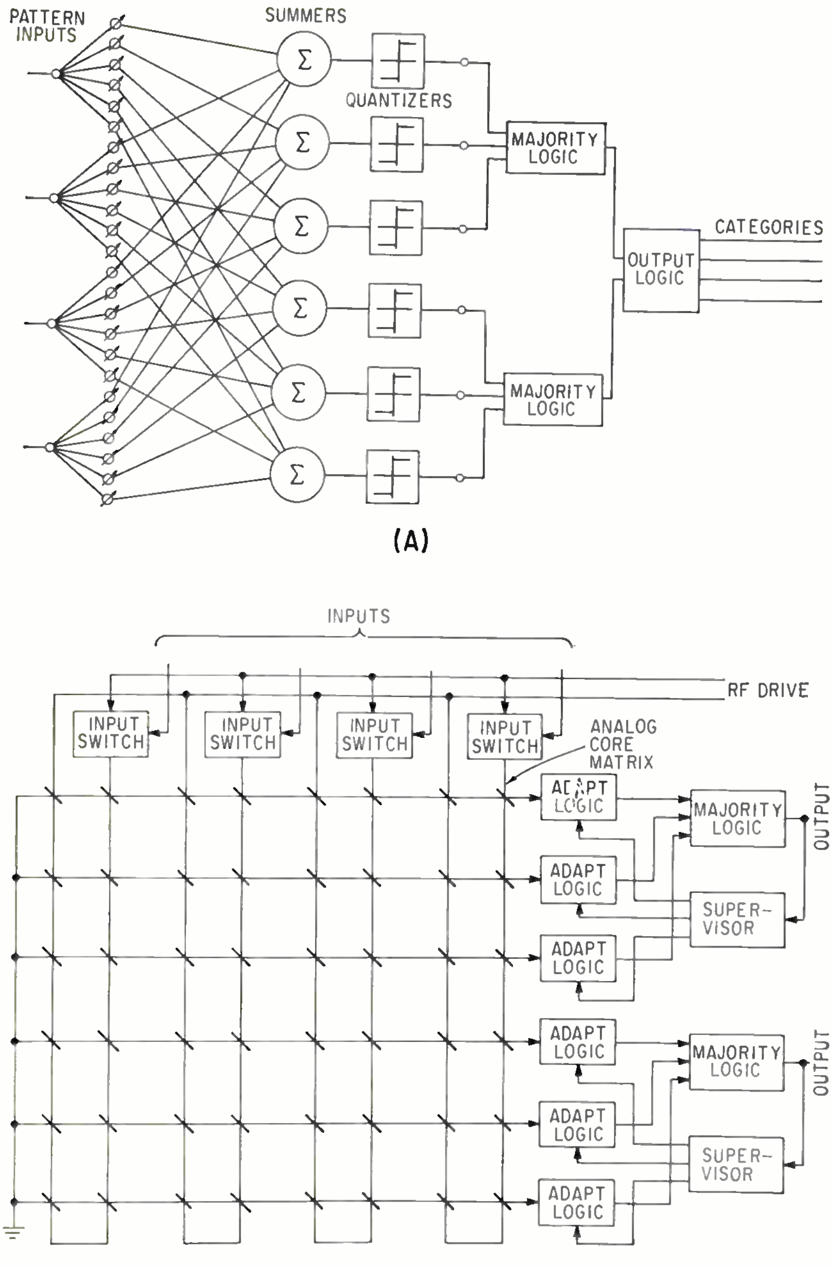
MAGNETOSTRICTION — The direction of the net remanent flux in a magnetostrictive core can be sensed if the core is excited mechanically. If the scheme shown in Fig. 1C, a magnetostrictive core is driven from an electromechanical transducer. The vibrations in the core produce an alternating change in the remanent flux that induces a voltage in the output winding; the phase of the output voltage depends upon the relative direction of the remanent flux in the core. The level of the remanent flux can be changed in either direction by pulsing the output winding. The drive level is adjusted so that the core is not demagnetized by the mechanical vibrations. The gain memory is excellent, but these devices have a large drive power requirement.

A better engineering solution has been obtained by coupling an ultrasonic delay line to the transducer. Magnetostrictive toroids are then placed on the line at intervals of one-half wavelength. The delay line mechanically excite several toroids which in turn produce an output voltage on the order of 100 mv. Figure 1D[3] shows the arrangement of the toroids.

Nondestructive readout may also be obtained by driving a magnetic core electrically. By reducing the drive to a sufficiently low value, the remanent state of a core made of square-loop material may be sensed in either of two modes. Since magnetic cores are, in general, nonlinear, the output voltage can contain harmonics of the drive current. In particular, the even harmonic voltages produced by the nonlinearities in the core are found to be proportional to the net remanent flux, so the remanent flux level can be detected by sensing the second-harmonic voltage. If the drive current is a pulse, rather than a simple sinusoid, the output voltage will likewise be a pulse of either polarity depending on the remanent state of the cores, independent of the polarity of the drive current pulse. Hence these devices may be operated with either a sinusoid or a pulse drive, and sensed accordingly.

MAGNETIC INTEGRATOR—The structure of a magnetic integrator, Fig. 2A, shows that the drive and sense windings are mutually orthogonal.[4] This reduces the direct coupling between these windings. Coupling must be kept small if the input pulse is not to appear directly in the output. The flux level in the core is altered by pulsing the output winding; the flux level is then sensed with pulses applied to the drive winding. The output pulses will be either positive or negative depending upon the direction of the remanent flux, with an amplitude proportional to this flux.

SECOND-HARMONICS—Another form of the magnetic integrator, Fig. 2B, is a second-harmonic generator consisting of a pair of tape-wound cores driven from an r-f sinusoidal power source.[5] The out-



ADAPTIVE SYSTEM *that classifies 4-bit patterns into four catagories (A), and the manner in which the cores can be arranged in a matrix (B)* —*Fig. 3*

put winding is arranged so that the induced fundamental component of the drive voltage cancels out, leaving a second-harmonic distortion voltage proportional to the remanent flux in the cores (indicated by the arrows). The remanent flux level can be altered by passing a direct current through the output winding. Due to an interaction bebetween the d-c adapt current and the r-f drive current, the rate of change of the remanent flux with respect to the adapt current is constant and reversible. Tape-wound cores are preferable to ferrite cores in this application by virtue of considerably superior performance and, because of a higher permeability, require fewer turns.

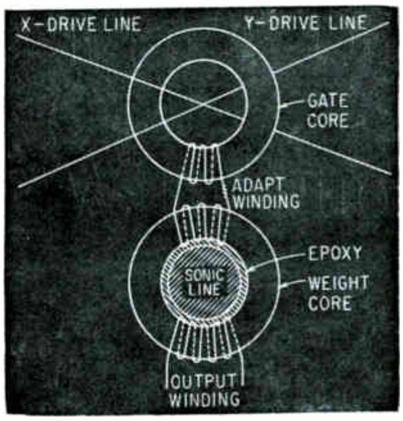
The variable gain components have all reached a stage of development where they can be used in the implementation of adaptive logic circuits. Any of the variable gain components may be used for weights. The memistor and the MAD component are usually operated in a bridge arrangement (Fig. 2C) to obtain negative weight values. The other components produce either positive or negative weight values without extra circuits.

MATRIX WIRING—A simple matrix scheme has been developed for wiring the cores used in second-harmonic magnetic variable gain components. In this scheme, the magnetomotive force required to adapt the second-harmonic components is much less than the coercive force of the cores. Because of this reduced threshold, the applied adapt current affects only those cores being driven by the r-f signal. Only those weights with an input of one can be adapted. This condition exactly fits the requirements of the system that has inputs of one and zero. With some additional logic, the system that has inputs plus one and minus one can also be accommodated.

The cores required for a simple adaptive system that can classify 4-bit patterns into four categories, Fig. 3A, are arranged in the matrix shown in Fig. 3B. The pattern is applied to the four inputs at the top of the figure. The inputs from the pattern operate the drive switches. Since two cores are required for each weight, the drive line is threaded down one column of cores and back up the next. The adapt lines are threaded through each row of cores. The summed output signal is taken from each of the adapt lines. Each pair of columns corresponds to an input to the system; each row corresponds to the output of an adaptive element.

Each input switch turns on a corresponding weight in each of the adaptive elements of the system. If the output of the element is wrong, an adapt signal, whose sign is determined by the sign of the summed output, is applied to the adapt line. This signal changes the gain of those variable gain components that have inputs of one, but does not alter the gain of the components that have an input of zero. The system is adapted by presenting input patterns in sequence and adapting the element when the output is incorrect. This procedure is repeated until all patterns are classified correctly.

The requirement for any matrix scheme is a coincidence logic circuit that will allow the adaption of only those weights with binary one input. Magnetic variable gain components using MAD cores or magnetostrictive toroids are adapted with short rise-time pulses of constant volt-time product. These adapt pulses are generated with a gate core, which can be incorporated into the coincidence logic scheme required for the matrix. Here, the gate cores are arranged in the matrix, and coupled to the weight cores as shown in Fig. 4. Signals on the x-drive lines corresponding to the inputs to the system and signals on the y-drive lines corresponding to incorrect outputs from the system cause the gate cores threaded by both these lines to adapt the associated variable gain components.



COUPLING *of a magnetostrictive component to its gate core—Fig. 4*

LOGIC—Returning to Fig. 3B, the logic required to perform adaptions according to the rule of systems with inputs of binary one and zero is shown in Fig. 5. Here the output signal from the adapt line in the analog core matrix is demodulated, quantized, and compared with the desired output signal, which is sent into the system along with the pattern. If the quantized output differs from the desired output, an adaption can take place where the adapt current will have the same sign as the quantized output signal.

If more than one adaptive element is to be incorporated into a system, which is the case if the matrix scheme is to be useful, some sort of supervisor is required to control the overall operation of the system. In Fig. 3B, majority logic could be used between the output of the six adaptive elements and the two output lines of the system. The output lines would then contain a binary one if at least two of the three adaptive elements feeding that line have an output of one. If this is not the case, the supervisor would cause the adaptive element that is least wrong to adapt until its output agrees with the desired output. The supervisor compares the analog outputs of each of the adaptive elements to determine which is the least wrong.

Of the various types of variable gain components, the second-harmonic magnetic variable gain component is the least expensive for systems with on the order of 10^4 weights. The extra cost of the tape-wound cores is compensated by the lower fabrication costs. This type of weight is still undergoing development, and may result in a further decrease in cost.

This simple class of adaptive systems, with a single layer of adaptive weights coupled with a subsequent layer of fixed threshold logic units, may be extended to include a layer of fixed threshold logic ahead of the adaptive layer. However, this is the present state of the art. New adaptive system theory is needed to allow formulation of rules by which a multilayer adaptive system is to be trained, and guarantee convergence of the sequence when two or more cascaded layers are being trained.

The Memistor was developed at Stanford University by M. E. Hoff and B. Widrow. A. E. Brain developed the MAD at Stanford Research Institute and the magnetostrictive components were developed at SRI by C. A. Rosen and G. E. Forsen.

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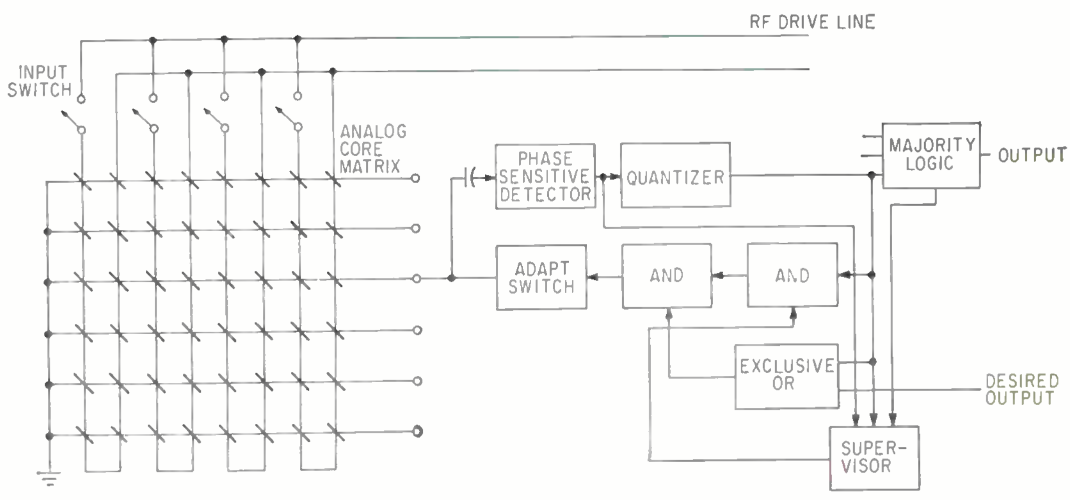
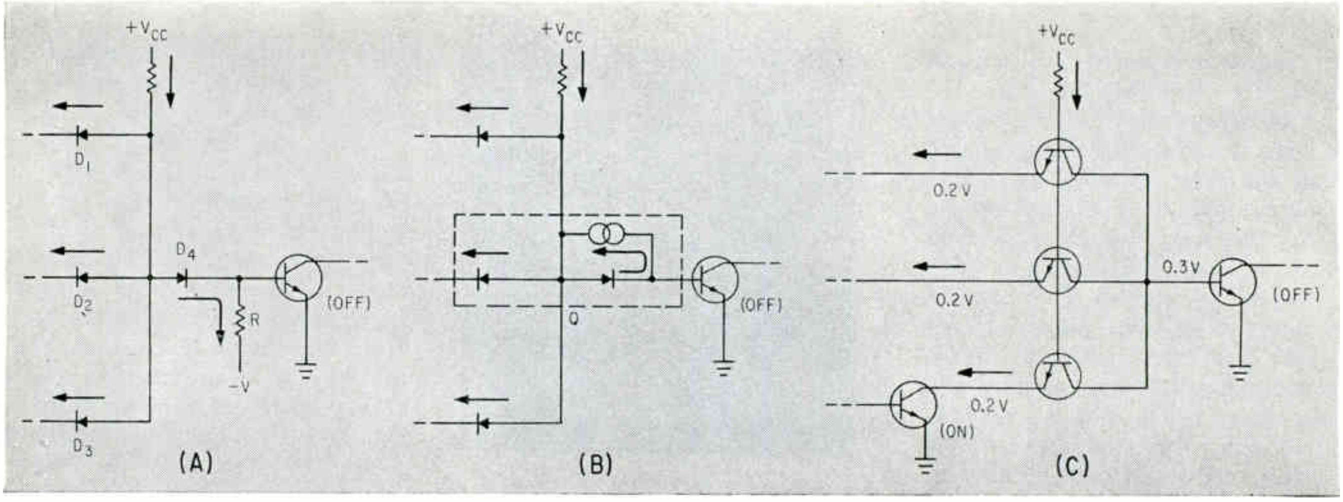


ADAPT LOGIC *required to perform adaptations with inputs of one and zero—Fig. 5*



LOW LEVEL *diode-transistor-logic (DTL) NAND gate (A) and a possible ideal solution (B). Development of TTL is shown (C)—Fig. 1*

FIRST DESIGN DETAILS Transistor-

Analysis of transistor-transistor logic circuits and their advantages over other types of logic

By H. W. RUEGG, Fairchild Semiconductor, Mountain View, California

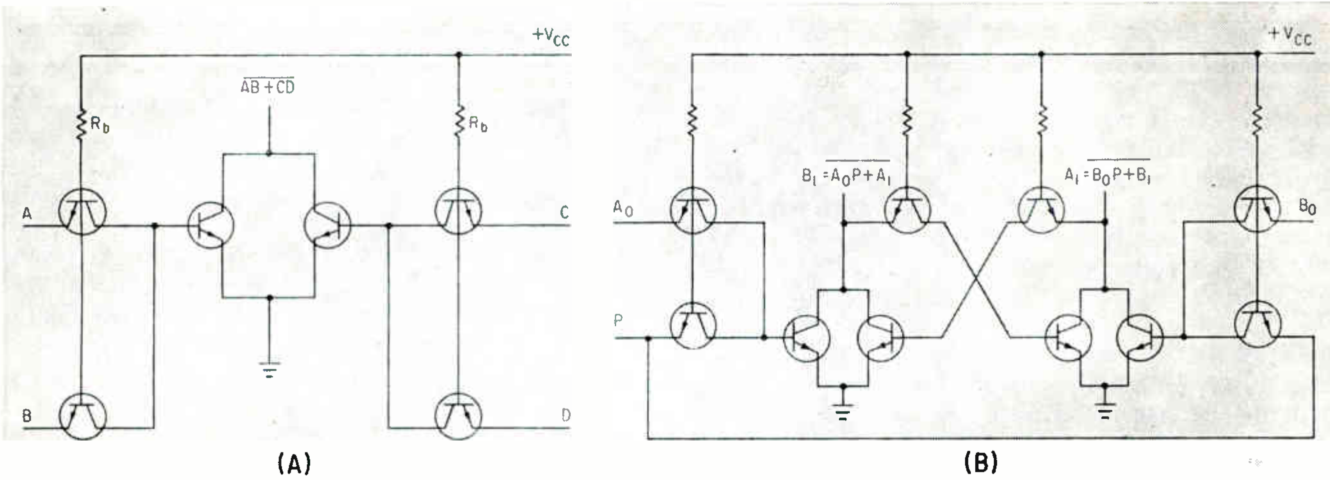
TRANSISTOR-TRANSISTOR logic (TTL) offers a saturated-transistor logic that is simple, compact, and has a high degree of design flexibility. High speed operation of very low power circuits is an additional feature.

Simplicity and compactness is achieved by employing a single supply voltage and a minimum of components. Design flexibility is increased because operating power level can be changed over a wide range by varying the node current while simultaneously retaining high fan-in and fan-out over this range.

EVOLUTION OF TTL—A well-known form of low level diode-transistor logic is shown in Fig. 1A. The gate gives the positive NOT AND or NAND function. If at least one input line connects to the collector of a transistor which is on, node current flows to the left and leaves the right transistor off. The current sink, $-V/R$, assures that current always flows through diode D_4, causing a drop that compensates for forward drops across diodes D_1, D_2 and D_3. This configuration has disadvantages of requiring a second supply voltage with an additional resistor each stage, and of reducing available drive current by draining away part of the node current.

An ideal solution would replace the current sink with a current generator, Fig. 1B. This not only removes the disadvantages, but also provides compensation for the diode voltage drops over a wide

LOGIC CIRCUIT *being tested in its completed form*



COMBINED TTL *and DCTL (direct-coupled transistor logic) parallel gates leads to NOT-AND-OR circuit (A). TTL gated flip-flop (B) is designed for minimum logic delay—Fig. 2*

Transistor Logic Circuits

current range as available current is rerouted through the level shifter diode.

The diode pair and generator combination (broken lines) is equivalent to a transistor. Thus the ideal case can be approximated with a gating transistor substituted for the combination. The resulting configuration, Fig. 1C, is called transistor-transistor logic (TTL or T²L).[1]

Logic operation is identical to the original DTL-NAND gate, Fig. 1A. If one or more input lines are connected to the collector of an ON transistor, node current will flow to the left. The base voltage of the inverter transistor to the right equals the collector saturation voltage of the preceding inverter, augmented by the offset voltage of the intermediate gating transistor. Values indicated in Fig. 1C are typical for silicon devices. The transistor to the right is kept off as required by the logic. But if all input lines are connected to off transistors, node current will flow into the base of the following inverter transistor.

TTL can be combined with DCTL type parallel gates. Combination NOT-AND-OR circuits, Fig. 2A, can be obtained. The TTL gated flip-flop, Fig. 2B, is an example of a design having minimum logic delay.

PROPAGATION DELAY—TTL is a low-level saturating logic similar to DCTL. It might be expected that the addition of gating transistors would reduce speed to considerably less than that of pure DCTL. Experiments show, however, that the propagation delay attributable to the gating transistors is less than 1 nanosecond and that this delay is nearly independent of their switching performance.

The reason is that a gating transistor is highly saturated in both states of operation. Voltages across the base-emitter and base-collector junctions change by about 50 mv during switching, so negligible delay arises from charging the junction capacitances. Experiments show no measurable difference in propagation delay between a circuit using gating transistors of small area and junction capacitances of 1-3 pf, and one using gating transistors with 10 times larger junction capacitances.

Minority carrier concentrations also remain nearly unchanged during switching. They are high in the base and collector regions and low in the emitter region for double-diffused structures. Thus large minority carrier lifetimes in the gating transistors will not materially affect switching time. In fact no reduction of propagation delay is observed when the lifetime of minority carriers in the gating transistors is decreased. Consequently the propagation delay of a TTL stage is primarily contributed by the

WHAT IS T²L?

Transistor-transistor logic uses transistor gates with the inverter transistor. The technique is new and it has the advantage of using only transistors and resistors. This makes it adaptable to integrated circuit manufacture switching speed of the inverter transistors.

In Fig. 3, experimental values for propagation delay of TTL and of the corresponding direct-coupled scheme (TTL less gating transistors) are plotted against current level. Propagation delay decreases with increasing fan-out values at current levels below the minimum delay point, because of higher collector current. Propagation delay stays approximately constant from −55 to 25 C and increases slightly with temperatures above 25 C. In Fig. 3, $N_{in} = 1$, $N_{out} = 1$, $V_{cc} = 3$, $T = 25$ C.

FAN-IN AND FAN-OUT—If TTL circuits are to be used as digital building blocks, the values of fan-in and fan-out insuring correct operation under worst case conditions must be known. In TTL each inverter transistor is associated with a gating block (Fig. 1C). Hence it has a potential base curent equal to the node current I_n', where

$$I_n' = (V_{CC} - V_{BE(on)} - V_{BC(sat)})/R_b \qquad (1)$$

Symbols are illustrated in Fig. 4A.

Collector current ideally is limited to node current I_n'' multiplied by the fan-out, where

$$I_n'' = (V_{CC} - V_{CE(sat)} - V_{BE(sat)})/R_b \qquad (2)$$

Under worst case conditions, however, base current available to an inverter transistor which should be on will be less than I_n'. A worst case circuit configuration is shown in Fig. 4B, where part of the node current of one inverter transistor is drained away through the emitters of the gating transistors. This is due to differences in the base on-voltages of the inverter transistors of the same fan-out family. Such unbalances can be caused by a difference in transistor parameters and/or by a large difference in collector currents. The additional current I^* flowing into the inverter transistors with a low value of base *on* voltage, is limited to

$$I^* \leqq \overline{\beta_I} I_n' \qquad (3)$$

as I^* must flow through the associated gating transistor in the inverse direction. $\overline{\beta_I}$ is the maximum direct-current gain of the gating transistors for inverted operation.

Also under worst case conditions the inverter transistors preceding the critical one will have the maximum allowed base voltage for the off-stage, $V_{BE(off)max}$, which is the voltage at which the transistor conducts maximum allowed off-current $\overline{I_o}$. This leads to an additional drive current loss through each gating transistor with an upper limit of $M\overline{I_o}$, if M is the maximum number of inverter transistors with joined collectors (DCTL-type parallel gates). Thus from Fig. 4B the worst case (minimum) base current $\underline{I_b}$ of the critical transistor is

$$\underline{I_b} = I_n' - \overline{N_{in}}\,(\overline{N_{out}} - 1)\,I^* - \overline{M}\,\overline{N_{in}}\,\overline{I_o}$$
$$= I_n'\,[1 - \overline{N_{in}}\,(\overline{N_{out}} - 1)\,\overline{\beta_I}] - \overline{M}\,\overline{N_{in}}\,\overline{I_o} \qquad (4)$$

The circuit configuration of Fig. 4C illustrates the second type of loss mechanism in TTL. The difference between the base on-voltage of Q_2 and the collector saturation voltage of Q_1 causes current I^{**} to flow through two gating transistors. The drive current of the critical inverter Q_2 is therefore reduced by the same multitude of the basic loss current as in Fig. 4B. Calculation shows I^{**} to be limited to

$$I^{**} = I^*/2 \lesseqgtr (\overline{\beta_I} I_n'')/2 \qquad (5)$$

Measurements on double-diffused transistors support the validity of this at low current levels and yield lower values for I^{**} at high current levels.

From the standpoint of base current reduction, the circuit configuration illustrated in Fig. 4B therefore represents the worst case. But as I^{**} is added to the basic collector current of an inverter transistor, the circuit configuration shown in Fig. 4C leads to a worst case (maximum) collector current of

$$\overline{I_C} = \overline{N_{out}}\,(I_n'' + I^{**})$$
$$= \overline{N_{out}}\,I_n''\,(1 + \overline{\beta_I}/2) \qquad (6)$$

To insure saturation of an inverter transistor, which by the logic is required to be on, the worst case ratio of collector current to base current must be $\beta_c < \underline{\beta_N}$, where $\underline{\beta_N}$ is the minimum normal current gain of the inverter transistors at the current level of interest. Thus.

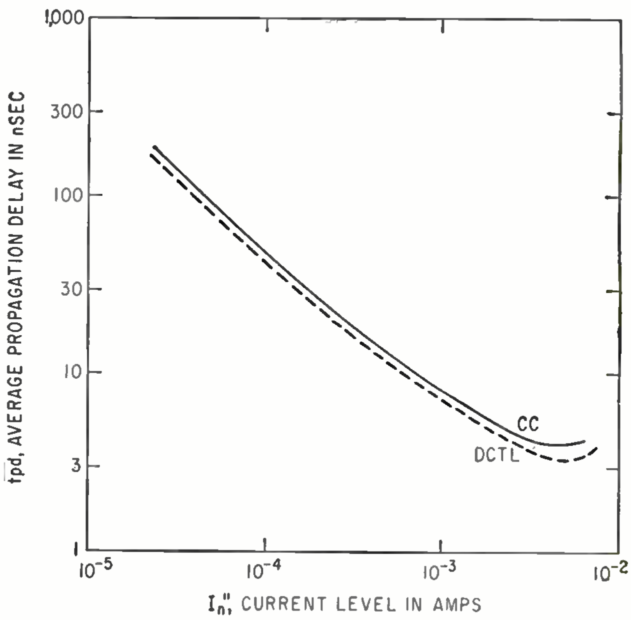
$$\overline{I_c}/\underline{I_b} = \beta_c < \underline{\beta_N} \qquad (7)$$

The degree of saturation β_n/β_c to be specified depends upon the desired noise margin. From Eq. 4 and 6 an expression relating fan-in and fan-out β_c and minimum inverse current gain of the inverter transistors can be obtained by

$$\beta_c = \overline{N_{out}}\,I_n''\,(1 + \overline{\beta_I}/2)\;/\;\{I_n'[1 - \overline{N_{in}}\,(\overline{N_{out}} - 1)\,\overline{\beta_I}[- \overline{M}\,\overline{N_{in}}\,\overline{I_o}\} \qquad (8)$$

$$\text{or } N_{out} = \beta_c\,[\,(I_{in}'/I_{in}'')\,(1 + \overline{N_{in}}\,\overline{\beta_I}) - \overline{M}\,\overline{N_{in}}\,(\overline{I_o}/I_n'')]/ [\,(1 + \overline{\beta_I}/2) + (I_{in}'/I_{in}''\beta_c\,\overline{\beta_I}\,\overline{N_{in}})] \qquad (9)$$

Loci of constant fan-in and fan-out in a β_c-β_I plane can be plotted, using Eq. 8 and 9, and are valid for a fixed temperature. As both the normal current gain (and thus the allowed $\beta_c < \beta_N$) and the inverse cur-



PROPAGATION DELAY *of TTL-NAND with current level. Type 2N709 transistors were used as inverters and for gating*—*Fig. 3* rent gain will change with temperature, however, the maximum allowed fan-in and fan-out values also vary over the temperature range.

Fan-in and fan-out values over a whole temperature range are important. As both current gains increase with temperature, fan-out calculated from Eq. 9 is assured over the whole temperature range, if β_N is measured at the low end and $\overline{\beta}_I$ at the high end of this range. This procedure is unnecessarily restrictive, however, because for a double-diffused silicon transistor (such as 2N709) the normal current gain increases two or three times faster with temperature than does the inverse current gain. Thus it is usually sufficient to insure a certain fan-in and fan-out at the low end of the temperature range.

NOISE MARGIN—Like DCTL, TTL is a low impedance, low level scheme, and is susceptible to ground plane noise. This can be minimized (and must be minimized for TTL) by using low resistance, low inductance ground conductors.[2] Referring back to Fig. 4A, the voltage at the base of an inverter transistor which is required to be off is

$$V_{BE(off)3} = V_{CE(sat)1} \Big|_{\frac{I_c}{I_b}} + V_{offset} \qquad (10)$$

Offset voltage of the gating transistor Q_2 is[3]

$$V_{offset} = V_{CE} \Big|_{I_C = 0} = (kT/q)\, ln[(1 + \beta_I)/\beta_I] \qquad (11)$$

This agrees with values measured for planar double diffused devices.

If the noise margin ΔV_n is defined as the difference between voltage $V_{BE(off)3}$ and the maximum allowed base voltage of an inverter transistor which should be off, $V_{BE(off)max}$, the worst case expression is

$$\Delta V_n = V_{BE(off)max} - V_{CE(sat)} \Big|_{\beta_c} - (kT/q) \ln[(1 + \underline{\beta_I})/\underline{\beta_I}] \qquad (12)$$

This indicates that, to achieve a high noise margin, the degree of saturation of the inverter transistors should be high ($\beta_c << \beta_N$), and gating transistors with a high inverse current gain should be chosen. Unfortunately, large fan-in and fan-out values require exactly the opposite. There is a tradeoff between fan-in, fan-out and noise margin.

The terms of Eq. 12 can be plotted against temperature. Because of two opposing tendencies (increasing β_I with increasing temperature and increasing kT/q), offset voltage varies only slightly over the temperature range. Temperature variation of the noise margin therefore is given mainly by variations of $V_{BE(off)max}$ and $V_{CE(sat)}$ of the inverter transistors.

The author acknowledges contributions of R. Shultz and D. Farina.

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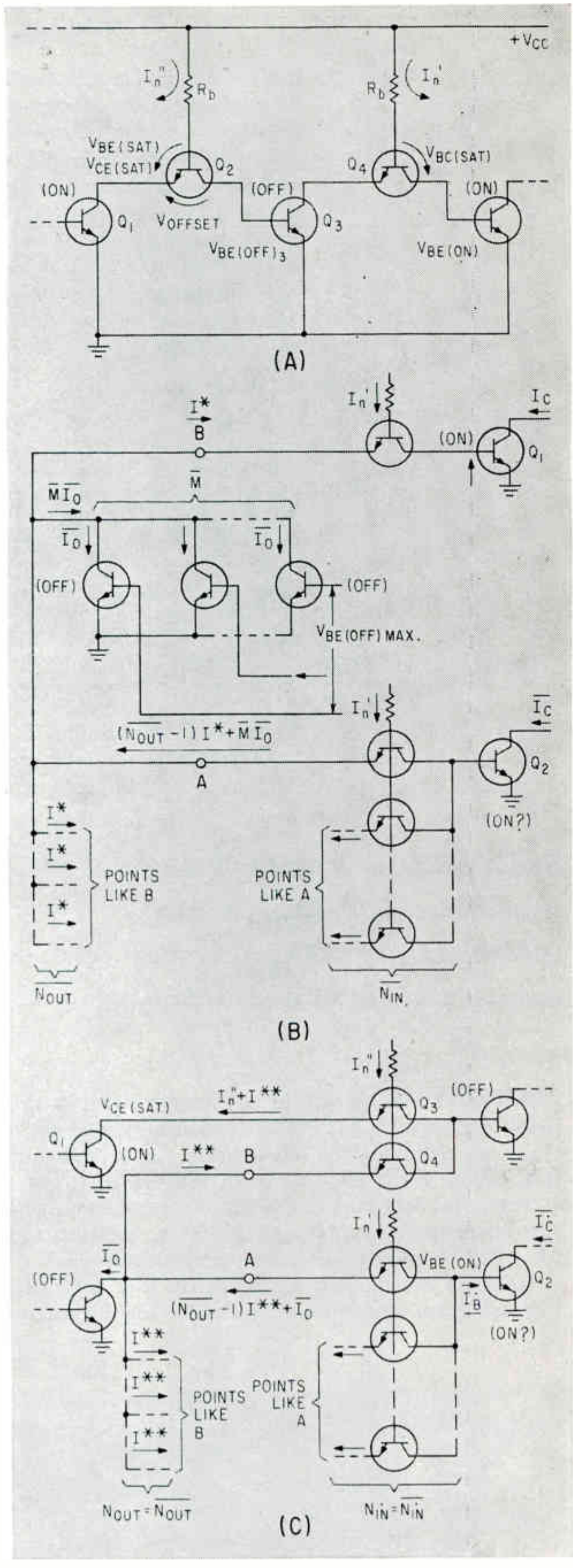

TWO TTL stages (A) with symbols used in the fan-out equations. Worst case circuit (B) where drive current is drained from Q_1 because of base voltage differences of inverter transistors of the same fan-out family. Base current (C) drained away from Q_2 adds to collector current of Q_1. Question mark indicates that under worst case conditions, Q_2 may not actually be on—Fig. 4

PAINLESS PROBE

Medical research has scrutinized the heart, lungs and kidneys for many decades until now these organs are pretty well charted and understood. But not so with the gastrointestinal tract.

Advent of the radio pill, which can telemeter information about temperature, pressure, oxygen concentration, acidity, and other variables, now changes the picture. At long last medical researchers have a tool which they can use to advance their rather primitive knowledge about the gut to a level of understanding comparable with that of the more accessible organs. In telling where the pill is sending its data from, this servo tracker adds immeasurably to the usefulness of the radio-pill technique

SERVO TRACKS PILL IN HUMAN BODY

By B. JACOBSON and B. LINDBERG
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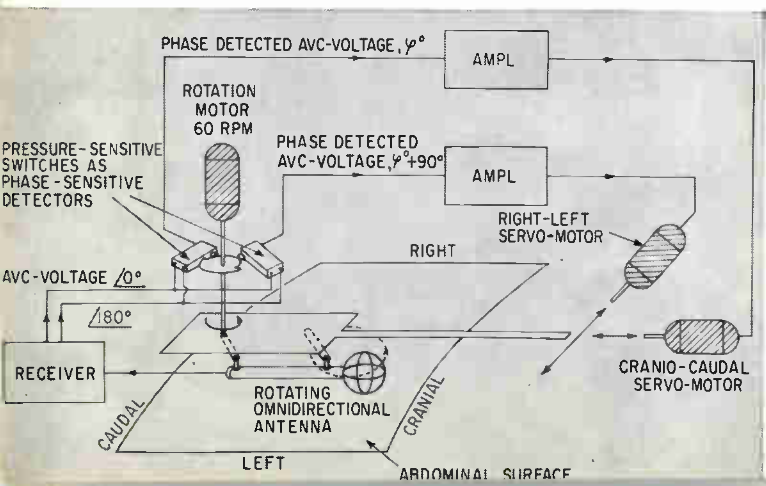
Radio pill telemeters f-m data about intestinal conditions; rotating antenna charts pill's journey by seeking position of constant signal

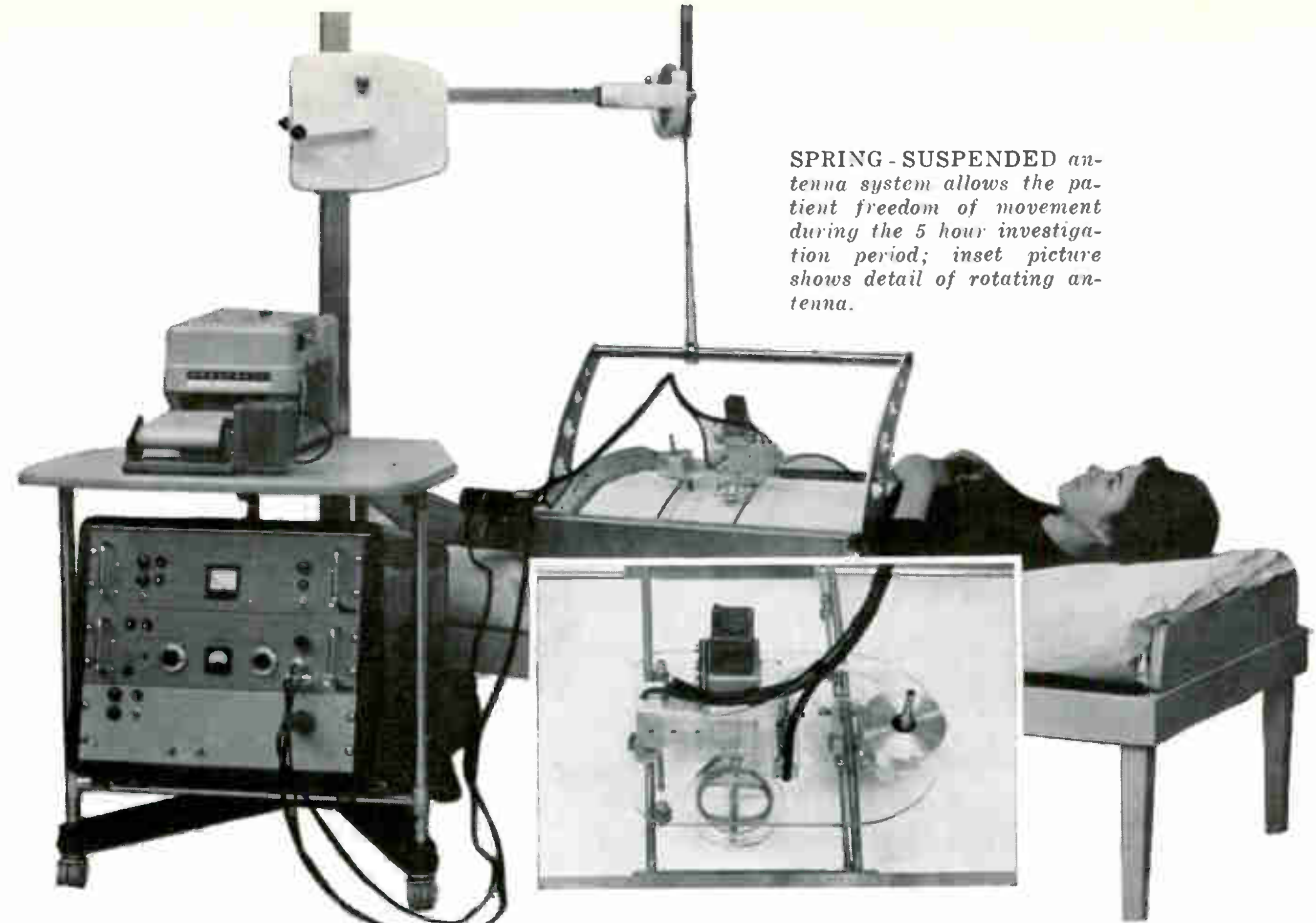
TELEMETRY from within the human body by tiny radio transmitters has become a routine procedure in studying physiological phenomena. Such transmitters, called endoradiosondes or radio pills, have a volume often less than one tenth of a cubic inch; they can telemeter such data as pressure, temperature, pH, enzyme activity and oxygen concentration.[1]

Pressure telemetering by radio pills is of particular interest since conventional methods for measuring pressures employing tubes or wires disturb the normal physiological conditions. They also tend to be painful, or at least, uncomfortable. The radio pills used in this study employ frequency modulation in the range 300-400 Kc, with frequency deviation 30 Kc or less. The variable inductance transducer consists of a rubber membrane acting on a ferrite rod moving in a coil. The oscillator circuit is a one-transistor Hartley with a power consumption of about 80 μw, giving a battery life of 3 weeks with an RM 312 mercury cell. The transmitting range is about one foot.

SQUARE MEAL—Because of their small size the radio pills can be swallowed and passed freely through the alimentary canal. Their mobility is a great advantage since they can pass along with the food during the digestion procedure, thus permitting observations that cannot be obtained in any other way. However, although the pill's mobility is very convenient, it does produce problems. As it is of limited interest to record data if their site of origin is unknown, it is necessary to follow the movements of a radio pill accurately. Moreover, the pill movement in itself is an important piece of information in studying gastrointestinal activity. Since the movements cannot be continuously followed by X-rays due to radiation hazards, a servoed antenna tracker has been designed.



SERVO SYSTEM *sends control signals to drive-motors, which then position antenna rotation axis to coincide with pill location—Fig. 1*



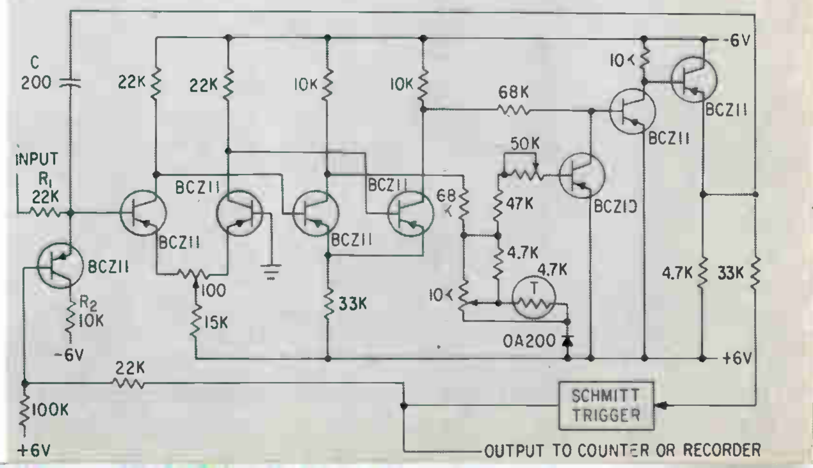
SPRING - SUSPENDED *antenna system allows the patient freedom of movement during the 5 hour investigation period; inset picture shows detail of rotating antenna.*

Tracking is accomplished by a rotating omnidirectional antenna mounted on a carriage, Fig. 1. The rotation occurs in a plane parallel to the abdominal surface. The resulting variation in the field strength, owing to the varying distance to the pill, generates an error signal in the antenna. This signal is detected by the receiving system, which controls two servomotors acting in perpendicular directions upon the antenna carriage to make the carriage to follow the movements of the radio pill. The carriage automatically seeks a position where the field strength is constant during the antenna rotation. This occurs when the rotation axis passes through or near the radio pill.

RECEIVER—Tracking relies upon the omnidirectional sensitivity of the rotating antenna. Signals from three mutually perpendicular loops are connected in turn to the r-f stage of the receiver. Signals from the three coils are switched sequentially by diode gates driven from a ring counter. The switching occurs at 25 cps, thus averaging the signal fed to the receiver each 0.12 sec. Averaging provides omnidirectional sensitivity.

The receiver has excellent frequency stability, with drift less than 20 cps per day. The receiver is a modified superheterodyne circuit with electronic tuning and is scanned at a 25 cps rate over the 30 Kc f-m channel sandwiched somewhere in the 300 to 400 Kc range. This scanning is accomplished by a sawtooth voltage applied to the tank circuit of the local oscillator, r-f and mixer stages. When the sawtooth voltage has the right instantaneous amplitude to tune the receiver to the frequency of the radio pill, a gating pulse is obtained from the detector. This pulse opens a gate for sampling the instantaneous value of sawtooth voltage, producing an output whose amplitude is a linear function of the frequency-deviation of the transmitted f-m signal. By storing the amplitude until the next scan occurs, a d-c signal is obtained, whose amplitude is proportional to the entity under study.

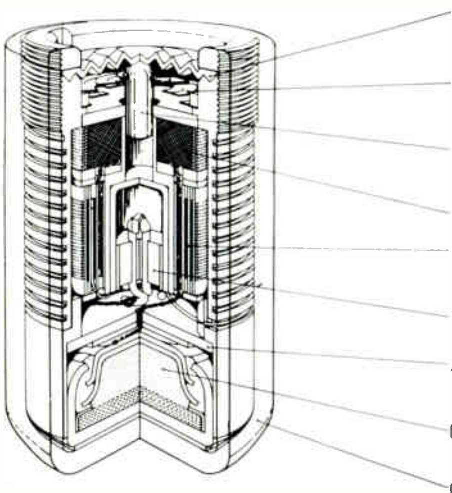
PHASE DETECTION—The error signal in the antenna during its rotation results in receiver avc voltage variations of the same frequency as that of the antenna rotation, 1 cps. The phase of the voltage



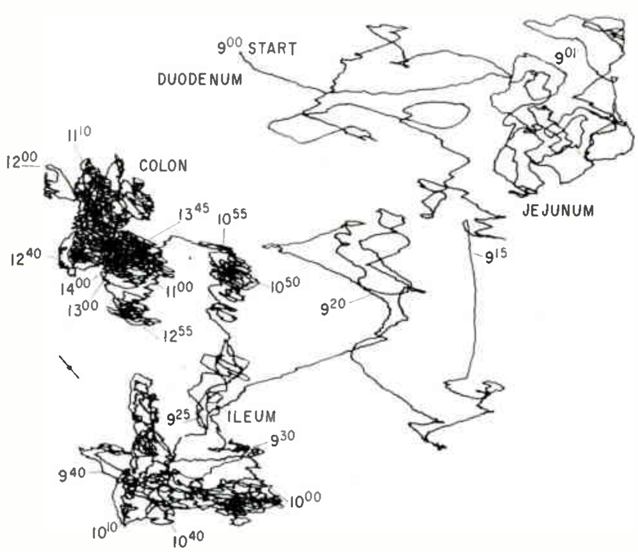
INTEGRATOR *charges capacitor C at rate proportional to signal from rate-generators; Schmitt output-pulses provide distance markers—Fig. 2* variations depend upon the relative positions of radio pill and antenna. To control the servo-motors a phase sensitive detection is made by two pressure actuated switches operated by a cam on the antenna shaft. By feeding the switches with two avc voltages 180 degrees out of phase, full wave rectification is obtained. The phase detected voltages from the two microswitches are 90 degrees out of phase, corresponding to the orientation of the two servo-motors that move the antenna carriage in the right-left and the cranio-caudal (up-down) direction respectively. Thus, the two switches deliver phase detected voltages that are proportional to the position unbalance in the two directions.

The avc voltages are obtained by rectifying the signal from the last m-f transformer. To obtain two 180-degree phase-shifted voltages, two similar rectifier circuits are used with the diodes turned in opposite directions. The 1 cps components of the avc voltages are amplified in two identical 90 db amplifiers before phase detection in the switches.

CHARTING—Radio pill movements are charted by an ink pen on a piece of paper supported by a curved Plexiglass plate resting on the abdomen. The pen is attached to the antenna carriage. Noise in the circuit results in a charting uncertainty of less than a quarter of an inch. This noise decreases with decreasing distance between the radio pill and the antenna.



RADIO-PILL *is slightly larger than the rubber eraser on an ordinary pencil*



FIVE *hour journey of pill through patient's gastrointestinal tract is chartered on this maze. Pill travels about 9 feet—Fig. 3*

INTERPRETATION—To interpret the results of intestinal studies it is necessary to determine the track length of the radio pill. The servo-motors are equipped with rate generators that deliver a-c voltages proportional to the momentary speed of movement in the right-left and cranio-caudal directions. The two voltages are added 90 degrees phase shifted, thus giving a voltage proportional to the speed of movement in the plane of the abdominal surface. This voltage is rectified and recorded.

The speed d-c voltage is integrated in a quantizing circuit to deliver a number of pulses proportional to the track length projected on the abdominal surface, Fig. 2. The transistor differential amplifier with an open loop voltage gain of 60 db is a conventional integrator that charges capacitor C, with constant R_1C. A Schmitt trigger controls the discharge of the capacitor through R_2. The frequency of the Schmitt trigger pulses is proportional to the input voltage in the range 2 to 200 mv within ±1 percent. Temperature stabilization is achieved by the diode and thermistor; the 10,000-ohm potentiometer adjusts the amplifier to minimum drift.

The equipment does not allow accurate measurement of pill-movement in the direction perpendicular (depth) to the abdominal surface. However a semi-quantitative recording can be made from the d-c level of the avc voltage. This voltage is a function of the distance, limited in accuracy by r-f absorption in the body tissues.

APPLICATIONS—Figure 3 shows the result of a five hour continuous tracking of a radio pill through the small intestine. The passage was unusually fast in this experiment influenced by the drug Prostigmine that enhances intestinal activity. As is seen in the figure, different parts of the intestine give track patterns of characteristic appearance. Thus, by observing the track pattern, it is usually possible to determine in what part of the alimentary canal the radio pill is located.

The intraluminal pressure waves for the different parts of the alimentary canal are of different types. The function of these waves is not quite clear. For instance, there are nonrhythmic pressure waves in the small intestine that have been assumed to have a propulsive action on the intestinal content. Detailed investigations with the servoed tracker have not confirmed this hypothesis.

ACKNOWLEDGMENT — This project was supported by a research grant A-2338 from the National Institute of Arthritis and Metabolic Diseases, U. S. Public Health Service.

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Faster Digital Communications With Duobinary Techniques

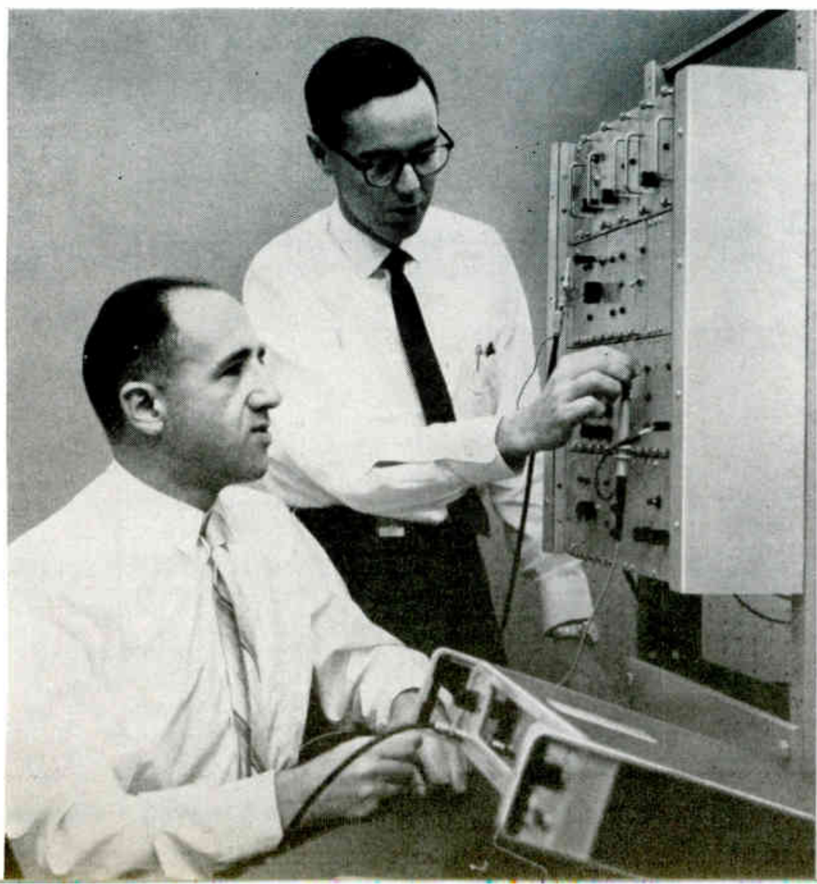
These arrangements permit speeds equal to those of quaternary systems but keep equipment simplicity on a par with binary methods. Here is a way to get transmission speeds as high as 3,200 wpm with these new techniques

By ADAM LENDER
Lenkurt Electric Co., San Carlos, Calif.

SEVERAL data transmission systems now available use a binary method of operation. However, these systems have restricted speed capabilities, and are limited in the number of information bits they can transmit in a specified period. This restriction is due to the bandwidth limitation of the associated data communication channel and results in an apparent limit of the number of times (per second) one binary state can be switched to another.

Techniques have been developed to increase the transmission rates of data systems over band-limited channels. Of these, the quaternary method results in a transmission rate that is double that of a binary system. While this method increases the operating speed, however, it also increases equipment complexity. In the quaternary method, a serial train of binary data digits is converted into two separate pulse sequences, each at one-half the speed of the original data pulses. Then, by superimposing one of the sequences on the other, a composite signal is formed. This signal has four possible states as compared with two for a binary system, and each quaternary state represents two binary digits, one from each of the two pulse sequences. In the presence of transmission impairments, the decoding process of the quaternary signal is more difficult than for a binary signal, since four states must be detected, rather than two.

AUTHOR *(left) and Gregor McGibbon adjust data transmission equipment in the laboratory*



The duobinary technique permits doubling the number of times per second one binary state can be switched to the other while preserving the binary form of the original signal. By compressing the bandwidth of a train of binary digits by a factor of two, duobinary coding allows a given data channel to accommodate twice as many duobinary digits as binary digits.

Bandwith compression is accomplished by converting a random sequence of binary digits into a correlated train of digits according to duobinary coding rules, where, binary ZERO (0 or SPACE) remains a ZERO; binary ONE (1 or MARK) can assume either a positive (+) polarity or a negative (−) polarity, each of equal magnitude, depending on the number of intervening ZEROS between the ONES; the polarity of the first ONE in the digit train is arbitrary; the polarity of the next ONE is the same as the polarity of the preceding ONE if the number of intervening ZEROS is even; the polarity of the next ONE is opposite to the polarity of the preceding ONE if the number of intervening ZEROS is odd; and the polarity of the next ONE is the same as the polarity of the preceding ONE if there are no intervening ZEROS.

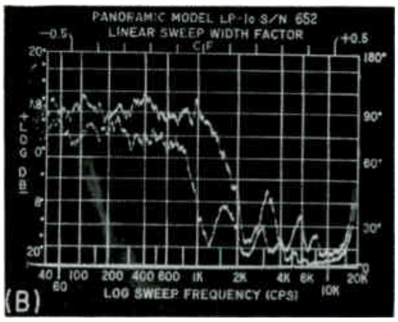
For example, B is the original binary data pattern and D is the resulting duobinary-coded train of data digits, as shown in Fig 1A. Sequence B is completely random in that the occurrence of ONE or ZERO in each time slot bears no relationship to the binary digits in the previous time slots. In sequence D, however, the polarity of each ONE depends upon the number of prior ZEROS as well as the polarity of the preceding ONE. Also, each digit in sequence D still represents either ONE or ZERO.

The net result of the binary-to-duobinary transformation is that the spectral density of the original binary sequence B is compressed by a factor of two. Theoretical proof of this, based on statistics of B and D, has been demonstrated,[1] and the experimental verification is shown in Fig. 1B. The spectral densities of a random binary sequence and a resulting duobinary sequence at a rate of 2,400 bits per second are shown in Fig. 1. In both sequences, nonreturn to ZERO (NRZ) pulses with no shaping were used. Both spectra have identical form and shape, except that the binary spectrum has minimums occurring at multiples of the data bit rate, (2,400 cps, 4,800 cps, etc.); the

B : 1 1 0 0 0 1 1 1 0 0 1 0 1 0 1 1 1 1 0 0 0 0 1

D : − − 0 0 0 + + + 0 0 + 0 − 0 + + + + 0 0 0 0 +

(A)

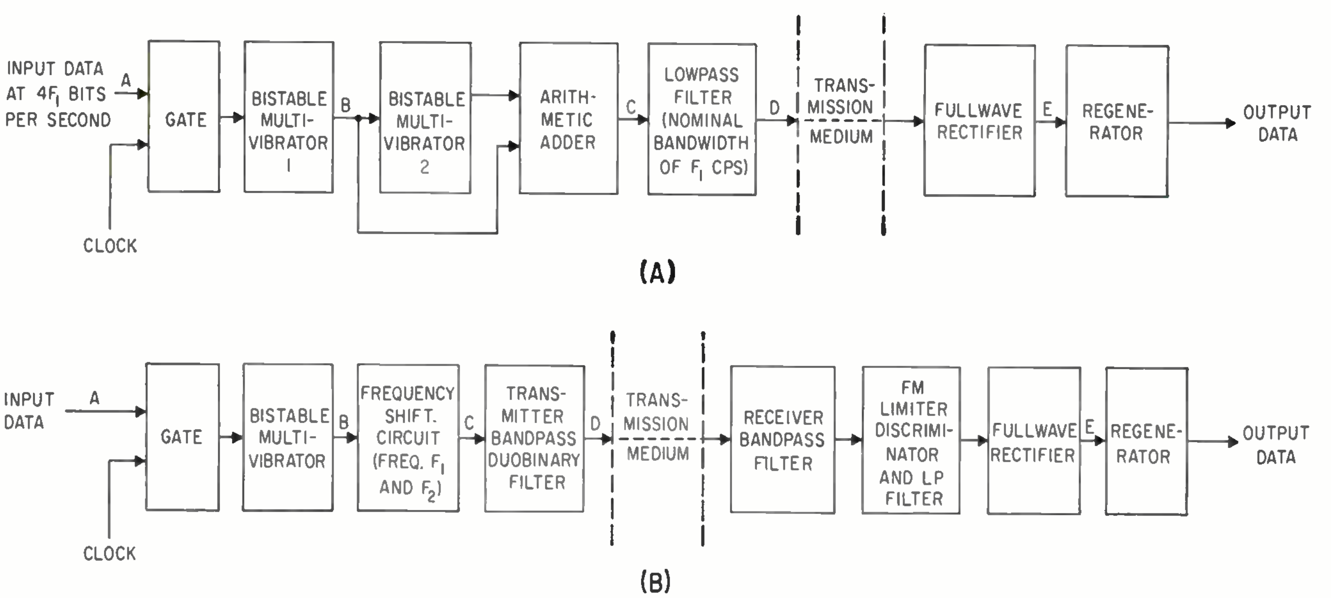


DUOBINARY-CODED *train of data digits (A) and spectral densities of binary and duobinary sequences at 2,400 bits-per-second (B) —Fig. 1*

duobinary spectrum has minimums occurring at multiples of one-half the data bit rate, (1,200 cps, 2,400 cps, etc.). The main lobe of the binary sequence contains 90-percent of the spectral energy, and extends from d-c to 2,400 cps; the corresponding lobe for the duobinary sequence extends to only 1,200 cps.

To illustrate the compression property of duobinary coding, suppose that a binary sequency consists of alternate ONES and ZEROS, such as: 1 0 1 0 1 0 1 0 1 0 1 0. The fundamental frequency of this periodic sequence equals one-half the data bit rate, and under ideal conditions, a transmission bandwidth equal to the fundamental frequency is sufficient to recover the data. When the binary pattern is converted to its corresponding duobinary sequence, + 0 − 0 + 0 − 0 + 0 − 0, the period of the sequence is twice that of the original binary pattern. Consequently, the fundamental frequency of the duobinary sequence is one-half that of the binary sequence.

BASIC SYSTEM — A basic data transmission system employing the duobinary technique is shown in Fig. 2A. Conversion from a binary to a duobinary form that is suitable for transmission over a band-limited channel is accomplished between points A and D. Input binary data pulses are gated into bistable multivibrator 1, and only input ZEROS cause a change in the state of the multivibrator. Bistable multivibrator 2 serves as a one-bit delay device. Its input (point B) and output are summed in the arithmetic adder to produce duobinary data pulses at point C. In some applications, such as in fsk data systems, bistable multivibrator 2 and the arithmetic adder may be omitted. In this case, the design requirements of the low-pass filter are more stringent. In either case, the low-pass filter has a half-amplitude point at f_1 cycles per second and can accommodate only 2 f_1 binary digits per second. In the duobinary system, the rate at points A and B is 4 f_1 binary digits per second. Therefore, the output wave at point D is band-limited by the filter, and is duobinary in form



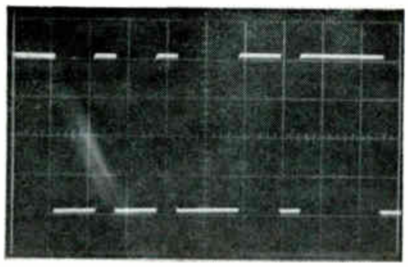
ELEMENTARY *duobinary data system (A) and block diagram of an f-m system (B)—Fig. 2* with ZEROS being represented by a center voltage level, and ONES by either an upper or a lower voltage level, according to duobinary-coding rules. The duobinary wave is reconverted to binary form at the receiving end after passing through a full-wave rectifier that changes all ONES to the same polarity. In the last step, a regenerator changes the analog form of the binary wave appearing at point *E* into a two-state replica of the original data. The regenerator accomplishes this by a quantizing process that detects ONES above and ZEROS below a predetermined slicing level. Retiming of the regenerated data is entirely optional.

The waveforms shown in Fig. 3 illustrate the pertinent duobinary processes during transmission of a 16-bit data pattern such as 1 1 0 0 1 0 0 1 0 0 0 1 1 0 1 1. Each waveform depicts an occurrence at a lettered point in Fig. 2A. For example, waveform 3B shows the pattern, 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 1, at point *B* of Fig. 2; and waveform 3C shows the digital duobinary form, + + 0 0 + 0 0 + 0 0 0 − − 0 + +, at point *C* of Fig. 2A. A data bit speed of 2,400 bits per second, which is equivalent to 3,200 words per minute was used, and the bandwidth of the transmitting low-pass filter at the half-amplitude point was 600 cycles per second.

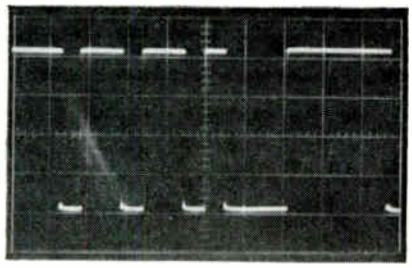
Any modulation method such as a-m, vestigial, f-m, or phase-shift keying can be used in a duobinary system. Since the most likely transmission media for digital-data transmission systems are voice-band telephone lines and high-frequency radio, f-m is suitable. Unlike a-m, vestigial, or suppressed-carrier phase-shift keying systems, no agc is required with f-m, and a large dynamic range can be achieved to assure a low sensitivity to line level changes. Also, analysis of high-frequency radio circuits shows that f-m is more resistant to fading and phase instabilities than other modulation techniques. An actual implementation of a duobinary f-m system is shown in Fig. 2B.

In Fig. 2B, the input binary data (point *A*) is converted to a new binary form (point *B*) in exactly the same manner as in Fig. 2A. Two frequencies, f_1 and f_2, are keyed in a strictly binary manner between points *B* and *C*. The separation between these frequencies (in cycles per second) is numerically equal to one-half the input data rate at points *A* and *B*. At point *C*, the signal wave is still in binary form, with ZEROS being represented by changes from f_1 to f_2, or from f_2 to f_1, and ONES being represented by no change. The function of the transmitting band-pass filter is to convert the modulated wave to duobinary form, shape the duobinary wave, and limit the frequency band of the signal so that it can be accommodated by the transmission medium. Since the band-pass filter passes only signal frequencies between and including f_1 and f_2 during, for example, a steady ZERO condition, all sidebands are virtually eliminated. A frequency that is an average of f_1 and f_2, termed the carrier frequency, will appear at point *D*. A ONE condition at point *D* is represented by either f_1 or f_2, depending upon the frequency of the last ONE in the sequence and the number of intervening ZEROS. Thus, the waveform at point *D* is duobinary f-m, although only two frequencies are actually generated in the equipment.

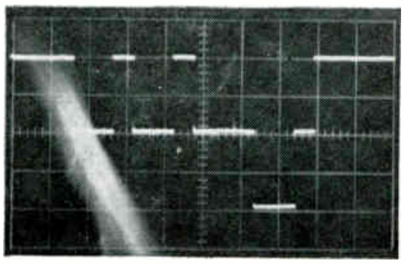
At the receiving end, standard f-m demodulation techniques are



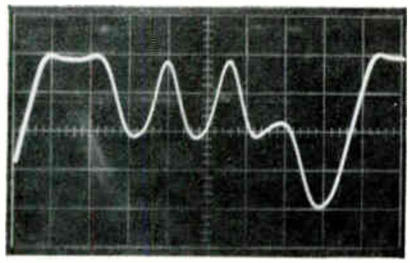
(A) 16-BIT BINARY PATTERN



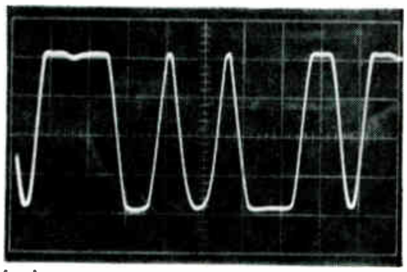
(B) DIFFERENTIAL 16-BIT BINARY PATTERN



(C) DIGITAL DUOBINARY PATTERN



(D) SHAPED DUOBINARY PATTERN



(E) RECTIFIED DUOBINARY PATTERN

BINARY *pattern of 16 bits (A), differential binary 16 bit pattern (B), digital duobinary pattern (C), shaped duobinary pattern (D) and rectified duobinary pattern (E) oscilloscope waveforms—Fig. 3*

3,200-WPM DATA TRANSMISSION SYSTEM

Conventional data transmission systems depend mainly on binary methods. This limits the amount of information they can transmit in a given amount of time because data channel bandwidth limitations slow switching from one binary state to another.

Here are details on the duobinary technique that doubles switching speed while retaining the binary form of the original signal

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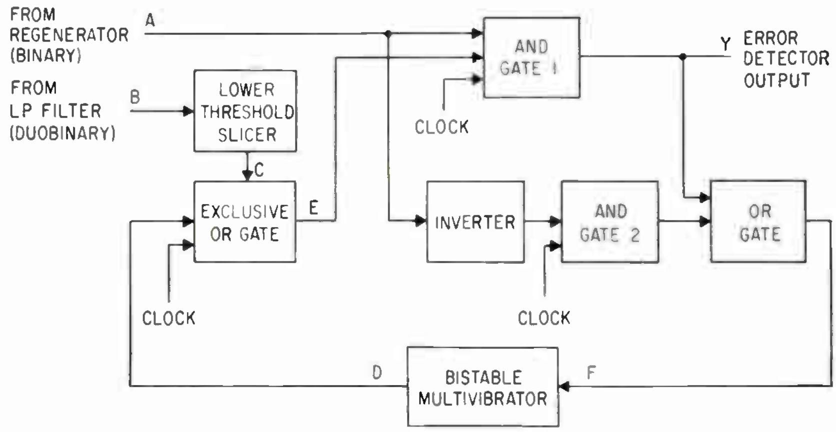
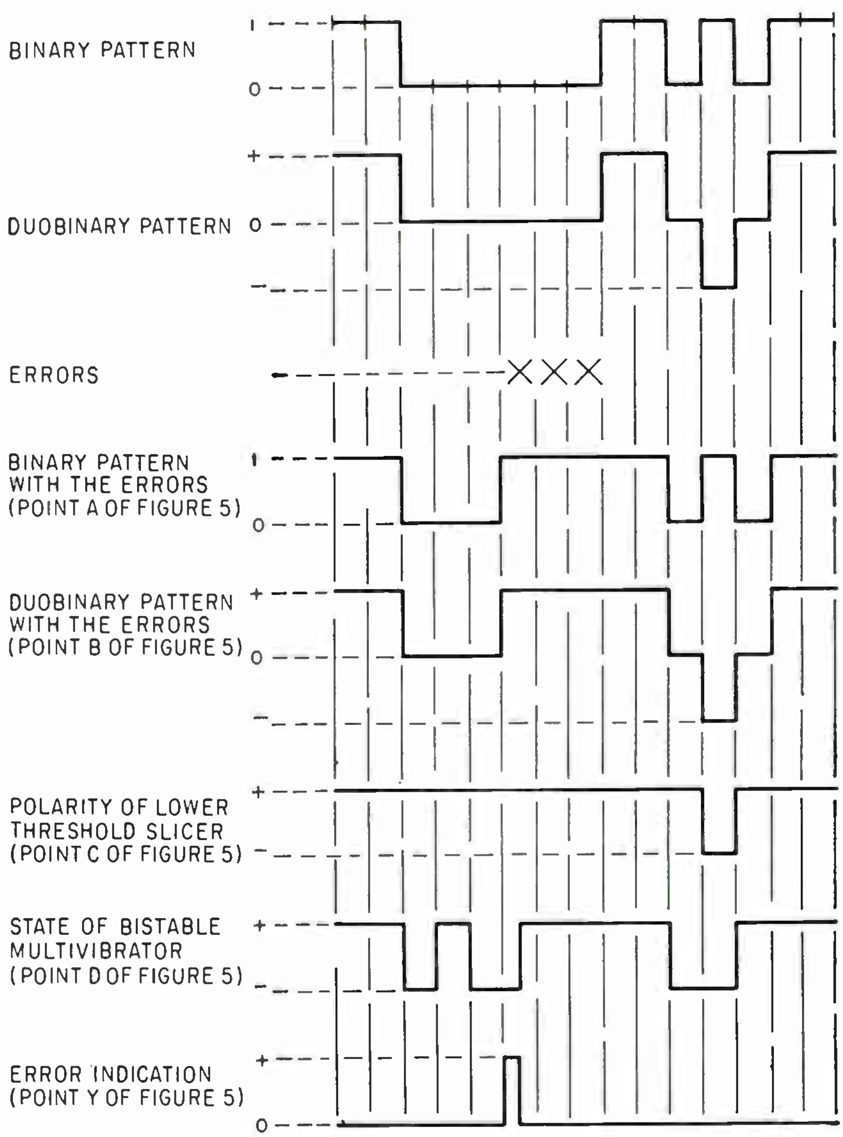


NEW *techniques are suitable for error detectors such as this—Fig. 4*



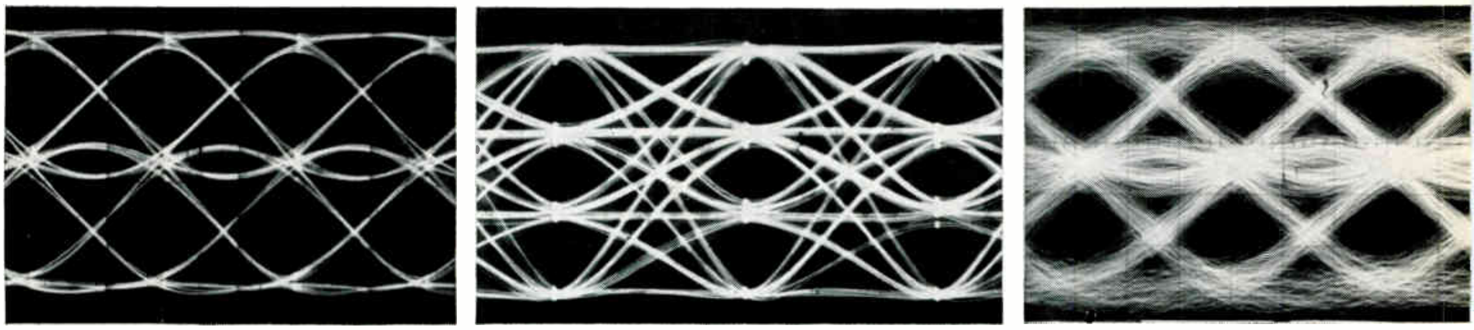
ERROR *detection process during the occurrence of a triple error—Fig. 5*

used. However, the bandwidth of the low-pass filter following the f-m discriminator can accommodate only a duobinary wave, since its nominal pass-band is one-fourth the data bit rate. Recovery of the two-state binary signals from the duobinary wave follows the same procedure indicated for Fig. 2A.

ERROR DETECTION—A unique feature of the duobinary technique in data transmission applications is the error detection that can be accomplished without introducing redundancy into the original data. In most binary or quaternary data transmission systems, the original random input data is also represented by random variations of carrier parameters, such as, amplitude, phase or frequency. In the duobinary technique, the random input data digits are converted to a correlated train of pulses following predetermined rules. This property of the duobinary technique is used to a great advantage in detecting errors. Odd-numbered errors can be easily detected as well as those even-numbered errors which violate duobinary principles. For example, odd numbered errors in a ZERO condition will result in an even number of ZEROS between ONES of opposite polarity, or in an odd number of ZEROS between ONES of identical polarity.

A block diagram of an error detector that consists of a bistable multivibrator, diode gates, and inverter, and a level slicer appears in Fig. 4. The function of the multivibrator is to remember the positive or negative state of the last ONE in the sequence, to count the number of ZEROS between ONES, and to predict the polarity of the first ONE (or ONES) following one or more ZEROS. In effect, the bistable multivibrator follows the duobinary pattern and violation of the duobinary-coding rules results in error indication.

In Fig. 4, the input at point *A* is supplied by the regenerator, and the input at point *B* is furnished by the low-pass filter. Both circuits are of course located at the receiving end. The output at point *C* is strictly binary, and is negative whenever a negative ONE is present; during a ZERO or a positive ONE condition, point *C* is positive. Also, the output at point



(A) (B) (C)

EYE PATTERNS *of the duobinary system (A), Quaternary system (B) and the duobinary system with white noise added (C)—Fig. 6*

D is positive and negative, respectively, during the positive and negative ONE conditions. As long as points *C* and *D* have identical polarities, there is no output at point *E*. But when points *C* and *D* have opposite polarities, an output at point *E* will occur during a ONE condition, if a violation of the duobinary pattern is detected. To assure that an output at point *Y* will occur only during a ONE condition, the error indicator supply line to a display (point *Y*) will be energized only when a ONE condition (positive voltage) is present at point *A*. In the event of an error indication, the bistable multivibrator is immediately restored to the proper polarity, since the error-indicating signal (point *Y*) will provide the appropriate change-of-state signal (point *F*) to the input of the multivibrator through an OR gate. Each ZERO (negative voltage at point *A*) is counted by the bistable multivibrator through an inverter, AND gate 2, and an OR gate. As a result, the multivibrator always has the same polarity as the last ONE, and counts the ZEROS. When the last ZERO appears, a prediction is made by the multivibrator on the correct polarity of the next ONE. An example illustrating the operation of the error detector during the occurrence of a triple error is shown in Fig. 5.

WAVESHAPE — Although the waveshapes resulting from the duobinary process may assume three amplitude levels, the technique has no relationship to a ternary technique. In a ternary system, all three voltage levels are equally probable, and a transition from any one level to any other level is possible. At any instant of time, the multi-level wave represents a ternary rather than a binary state, whereas a duobinary wave at any instant of time, represents a strictly binary ONE or ZERO. In the duobinary case, a transition from a positive to a negative ONE, or from a negative to a positive ONE is impossible, since two successive ONES always have identical polarities. Furthermore, a duobinary system has the same bit information capacity as a quaternary system and twice that of a binary system. This, however, is not true for a ternary system.

EYE PATTERNS—Data transmission systems can be compared by their eye patterns. These patterns not only provide an excellent measure of intersymbol interference, but also serve as a good criterion for analyzing the transmission qualities of data systems. The eye pattern is a superposition of many data patterns from a source like a random binary-digit generator, and is observed on an oscilloscope that is externally synchronized with the data bit rate. The eye is the clear area that exists between the amplitude levels; the larger the eye opening, the more margin there is for noise and other impairments. The pattern of a duobinary system has an upper and a lower eye. A quaternary system has three eyes and four distinct voltage levels and the transition from one level to any other level is equally probable. Consequently, there is a considerable amount of inter-pulse interference between successive quaternary symbols. Figures 6A and 6B show eye patterns of both systems, with each operating at 160 bits-per-second over the same bandwidth. To evaluate the noise margin of the two systems, the same amount of white noise was continuously added. At the point where the eye pattern of the quaternary system was almost obliterated due to the noise, the duobinary pattern maintained a fairly good noise margin as shown in Fig. 6C, and had an error rate of one error-bit per million transmitted bits.

Another interesting comparison between duobinary and other data transmission systems is the degree of equipment complexity required. With the single exception of a rectifying stage at the receiving end, a duobinary f-m system has the same amount of circuitry as a straight binary f-m system. However, the duobinary system has twice the speed capability. When compared to an efficiently implemented differentially coherent four-phase modulation system, a duobinary f-m system is far less complex and, only requires about one-half the circuitry.

The last factor to be considered in the assessment of the duobinary technique is performance. The measured values of the normalized signal-to-noise ratio (signal power-per-bit divided by white noise power-per-cycle-per-second) at various operating speeds indicate that only a 3 db difference exists between a duobinary and a binary system. A typical normalized signal-to-noise ratio for a duobinary system is 16.5 db with a resulting error rate of one error bit per one million transmitted bits. If wire telephone lines are used as the medium, the 16.5 db figure allows more than adequate margin.

REFERENCE

(1)—A. Lender, "The Duobinary Technique for High Speed Data Transmission," paper 63-283, *IEEE* Winter General Meeting, Feb. 1, 1963

DIRECT COUPLING SHRINKS

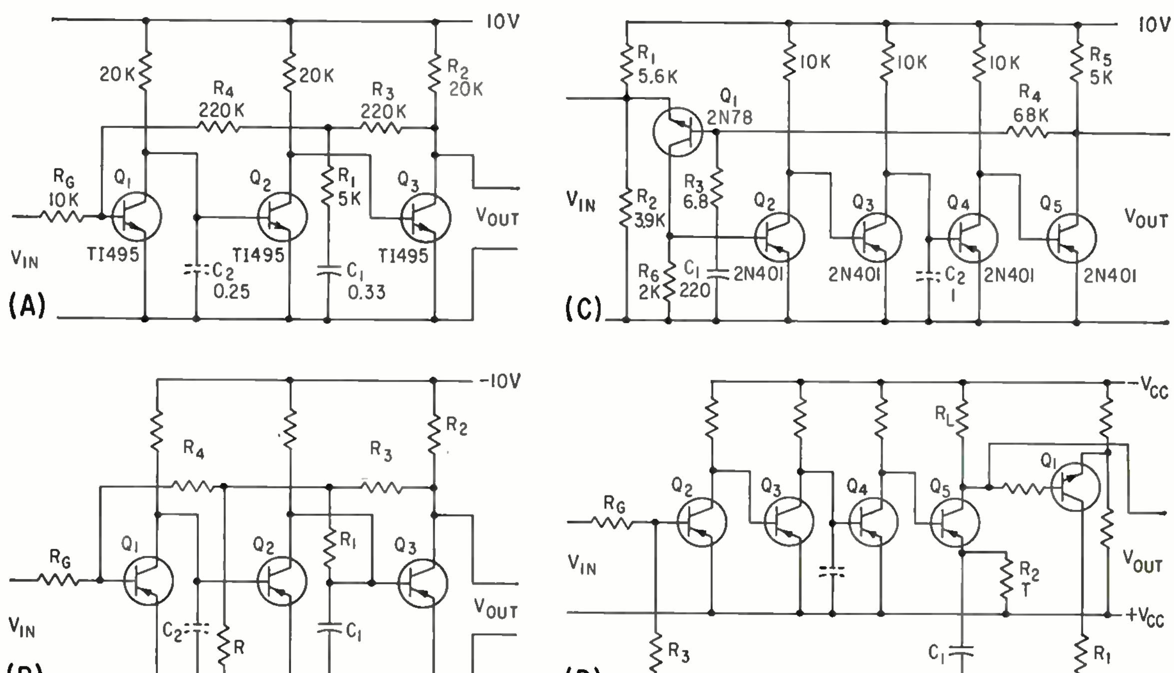
Feedback from final to first stage sets the bias level of multistage amplifier, eliminates bulky capacitors and makes circuit compatible with microelectronic fabrication techniques

By PETER LAAKMANN, American District Telegraph, 155 Sixth Avenue, New York

THE USUAL TECHNIQUE in designing high-gain wide-band a-c amplifiers is to stabilize each stage for d-c operating point and then capacitor-couple the individual stages. This usually calls for a number of large electrolytic capacitors to shunt the emitter stabilizing resistor, plus a coupling capacitor for each stage. Minimum size of the finished amplifier is then limited by the size of the electrolytics.

A more economical approach may be to couple all stages directly and apply output-to-input a-c and d-c feedback to the circuit. To achieve stability of a multistage amplifier it is necessary only that the d-c output current of the last stage can be controlled by a d-c input current to the first stage under all circumstances. Then any degree of d-c output current stability can be obtained by providing an output current sensing circuit which controls the input d-c current in a degenerative mode. Therefore, a-c gain is obtained by shunting the control loop with a capacitor and gain stability by negative feedback across all stages.

STABILITY—Current derived stabilization produces the simplest direct coupled a-c amplifier that can be built, Fig. 1A, using only one capacitor. Gain stability can be made reasonably good by choosing resistor R_1 to give sufficient negative feedback. However, output current stability is poor and output current is highly dependent on the common emitter current gain of the first transistor. Output voltage swing is limited to a fraction of the supply voltage since the normal d-c operating point of the last stage has to be chosen for a collector voltages of about 20 percent of the supply voltage.



CURRENT DERIVED *stabilization (A), Shunted-base current-derived stabilization (B). Circuit with bridge derived stabilization (C) has component values worked out in text, alternative version of bridge stabilized circuit (D)—Fig. 1*

AMPLIFIER SIZE AND COST

THREE - STAGE *shunted-base amplifier with current derived stabilization is highlighted at right hand tip of circuit card*

The transistors should have good current gain at zero collector to base voltage, as this is the operating point for all but the last stage. Most silicon transistors, and a number of germanium transistor types do. Germanium mesa transistors are especially useful but they suffer from poor noise figure. Current gain of germanium alloy switching transistors at zero V_{CB} is a function of temperature, decreasing with increasing temperature. More negative feedback is therefore required to stabilize gain over a given temperature range than if silicon transistor or mesa transistors are used.

Common emitter current gain cut off frequencies for transistors in the amplifier have to be at least an order of magnitude above the upper cut off frequency for which the amplifier is designed, if negative feedback is to be provided from R_{1}. Feedback is applied over at least three stages, which can result in a phase shift at some high frequency equaling 180 degrees. If the beta cut off frequency is chosen too low, the amplifier would tend to oscillate at a frequency not much higher than the upper cut off frequency. Adding C_2 (shown dotted in Fig. 1A) can reduce the gain for higher frequencies and eliminate instability, but the cut off frequency would then be too low. For example, to design a 10-Kc cut off amplifier using transistors with a beta 50 would take a beta cut off frequency in excess of 100 Kc, even if only a moderate amount of feedback is used. An alpha cut off frequency of 5 Mc is therefore the absolute minimum.

Lower cut off frequency of the amplifier is given by

$$f_L = 1/2\pi R_1 C_1 \qquad (1)$$

provided the closed loop gain is controlling the amplifier gain. Closed loop voltage gain under this condition is

$$A_b = R_3 R_4 / R_1 R_G \qquad R_2 \ll R_3 \qquad (2)$$

If the generator impedance is not resistive, a series resistor may be required to avoid additional phase shift. Also, capacitive loading at the output can cause instability under some circumstances.

DESIGN PROCEDURE—Assume that transistors with a total beta range of 50 to 200 (initial, temperature and aging) are to be used. Lower cut off frequency is 100 cps and the supply voltage is 10 v. Generator impedance is 10,000 ohms and voltage gain is to be 60 db. Transistors are silicon so that I_{CBO} is no problem. Collector current should be 0.5 ma per transistor.

At 0.5 ma all load resistances are 20,000 ohms. Gain of 60 db can be handled by a three-stage amplifier since current gain per stage is at least 50.

Base current for a 0.5-ma collector current is 10 μa at minimum beta. The input transistor will need 10 μa and this current will be supplied from the output. The output voltage can only be 10 v and at that the current would have to be zero. A maximum voltage of 5 v should be allowed. For silicon, V_{BE} is approximately 0.5 v, so that 4.5 v are available across R_4 and R_3. Thus $R_4 + R_3 = 4.5/10^{-5} =$ 450,000 ohms. Resistors R_3 and R_4 should be equal so that their product is highest, resulting in highest value of R_1 for a given voltage gain, Eq. 2. This will minimize C_1. If $R_4 = R_3 =$ 225K (220,000 ohms), R_1 is then 5,000 ohm, Eq. 2. For f_L = 100 cps, C_1 becomes 0.32 μg.

At maximum beta of 200, input current would be

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- Absence of several bulky electrolytics reduces amplifier volume, prunes cost and simplifies assembly.
- Amplifier operates at zero collector-base volts, a condition for minimum noise.
- Amplifier is direct coupled throughout suggesting microelectronics manufacturing techniques, with the whole amplifier built in a single chip of silicon, feedback and dampng network being added externally

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2.5 μa. Output collector voltage would then be 0.5 + 2.5 × 0.455 = 1.65 v. Voltage swing would be limited to 3 v peak-to-peak.

Shunted base current-derived stabilization can be provided if a shunt resistor is added in parallel with the base-to-emitter junction of the input transistor. Similar results can be obtained if this resistor is added in parallel to the R_1C_1 combination. The latter is preferable since it does not affect the signal. The circuit is shown in Fig. 1B.

The shunt resistor stabilizes the output current with respect to beta variation of the first transistor. However, its introduction will cause variation of output current due to temperature-induced variation of V_{BE}. For conditions of limited temperature range, an improvement in output current stability over the circuit in Fig. 1A can be obtained.

The resulting stability is sufficient for some applications. Calculation of values is difficult. The best approach is to use limit transistors at high and low temperatures. Equations 1 and 2 are applicable for this amplifier, as the a-c parameters are not affected by shunt resistance. The shunt resistance will also prevent I_{CBO} problems in some low leakage germanium transistors (MADT, MESA types).

Bridge derived stabilization can also be obtained. Figure 1C shows the basic circuit. Figure 1D is a modification of the basic scheme and Fig. 2A is an amplifier constructed along the lines of Fig. 1D but using emitter follower input to provide a current sensitivity of 0.1 μa per ma of output current.

Operation of the amplifier Fig. 1C is as follows: the emitter of transistor Q_1 is held at approximately half the supply voltage. Collector voltage of transistor Q_6 is slightly lower to produce a base current in Q_1 sufficient to establish the operating point of Q_5. Transistor Q_6 will then be biased to provide symmetrical voltage swing. Any tendency of the collector voltage of Q_5 to change will be counteracted by a large base current change in transistor Q_1.

Voltage gain of the amplifier in Fig. 1C is R_4/R_3 if the open loop gain is high. Lower frequency cut off is $f_L = 1/2\pi R_3C_1$. The a-c stability considerations are similar to those of Fig. 1A and 1B. However, input impedance can not cause instability in Fig. 1C, as the feedback loop is isolated from the input.

Voltage gain for Fig. 1D is $A_v = R_3R_1/R_2R_g$.

Lower cut off frequency for Fig. 1D is not clearly defined. It is a function of the voltage gain of transistor Q_1 and the time constant of C_1 R_3 and R_2, in addition to the gain of the amplifier. Maximum output signal swing is essentially equal to the supply voltage since V_{CE} of Q_6 can be held constant.

Two amplifiers of the type shown in Fig. 1C can be cascaded directly if R_5 is not more than about half the resistance seen at the emitter of Q_1.

DESIGN EXAMPLE—Assume an amplifier is to be constructed along the lines of Fig. 1C. Lower cut off frequency is to be 100 cps and voltage gain 80 db at a supply voltage of 10 v. Operating point is 1 ma and V_{CE} of transistor Q_5 will be at 5 v and under no circumstances drift more than ±1 v. Beta for transistors Q_2 to Q_5 are 40 minimum, and I_{CBO} is 25 μa at highest operating temperatures, using germaniun transistors. Transistor Q_1 has the same specification but is *npn*. Load resistors of transistors Q_2 to Q_4 will be 10,000 ohm, that of transistor Q_6, 5,000 ohms.

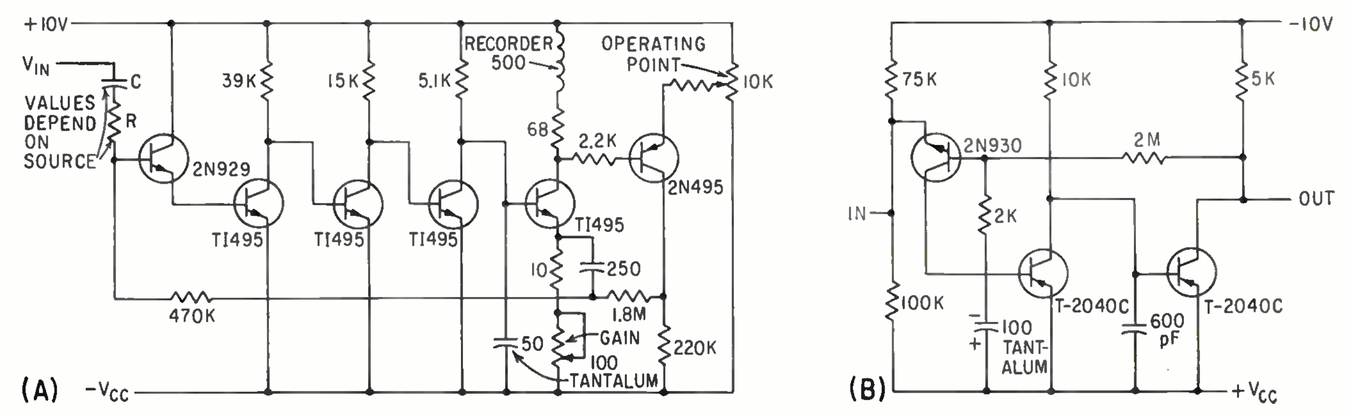
Resistor R_6 carries the I_{CBO} of Q_1 and Q_2. At V_{BE} of 0.1 v, Q_2 will still be turned off; R_6 is therefore $0.1/50 \times 10^{-6}$ = 2,000 ohms.

Base current of transistor Q_2 will have to be 25 μa to deliver 1 ma collector current at lowest beta. At lowest operating temperature V_{BE} is 0.3 v so that total collector current supplied by Q_1 is $0.3 \times 10^{-3}/2.0 + 0.025 \times 10^{-3}$ = 175 μa.

Base current needed for transistor Q_1 is then 175/40 = 4.5 μa. This current has to be supplied by R_4. Since total V_{CE} change of transistor Q_5 is 2 v and the total current change in R_4 is 4.4 μa in one direction and 25 μa in the other, then I_{CBO} = 29.4 μa or approximately 30 μa, so that $R_4 = 2 \times 10^6/30 \approx 68{,}000$ ohms.

At 80-db gain, R_3 is 6.8 ohms. Capacitor C_1 is 235 μf for a 100-cps cut-off frequency. A 220 μf tantalum capacitor should be used. (A silicon transistor for transistor Q_1 would allow the use of a smaller capacitor, since R_4 could be increased.) The normal V_{CE} of transistor Q_5 is 5 v and the nominal current in R_4 is 15 μa in the reverse direction. Base voltage of transistor Q_1 would be 5 − (0.015 × 68) = 4 v.

Emitter potential of Q_1 should then be approximately 4.2 v to allow 0.2 v for V_{BE}. Divider current is chosen at 1 ma to stabilize the emitter potential so that R_2 should be 3,900 and R_1 5.600 ohms. Capacitor C_2 should be found experimentally.



BAND-PASS AMPLIFIER *(A) drives recorder in 0.2 to 5-cycle range; wideband amplifier with 60 db gain (B) uses Philco T-2040 C transistors for frequency range 1 cycle to 1 Mc—Fig. 2*

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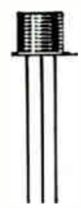

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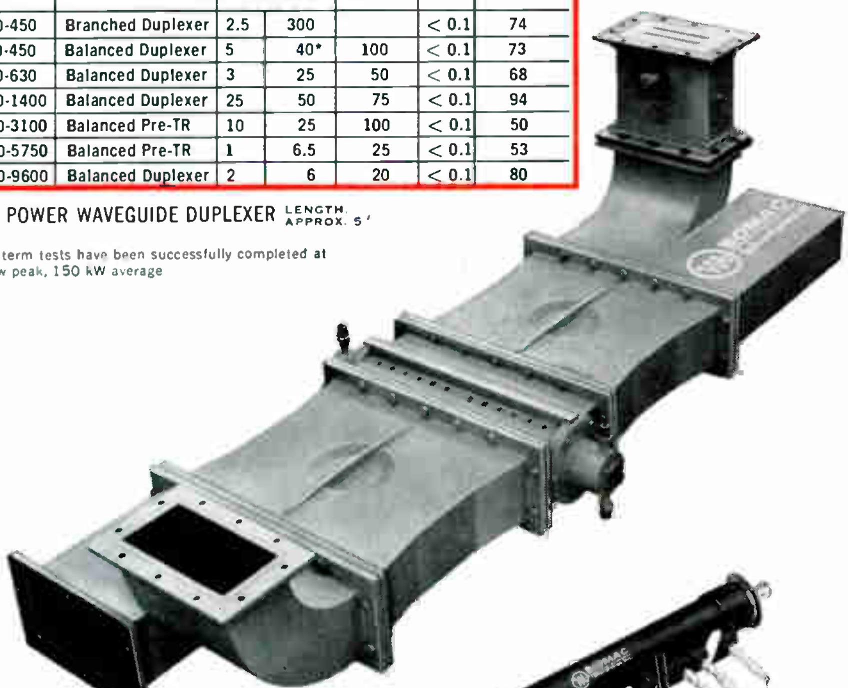
400-450	Branched Duplexer	2.5	300		< 0.1	74
400-450	Balanced Duplexer	5	40*	100	< 0.1	73
570-630	Balanced Duplexer	3	25	50	< 0.1	68
1250-1400	Balanced Duplexer	25	50	75	< 0.1	94
2700-3100	Balanced Pre-TR	10	25	100	< 0.1	50
5250-5750	Balanced Pre-TR	1	6.5	25	< 0.1	53
8400-9600	Balanced Duplexer	2	6	20	< 0.1	80



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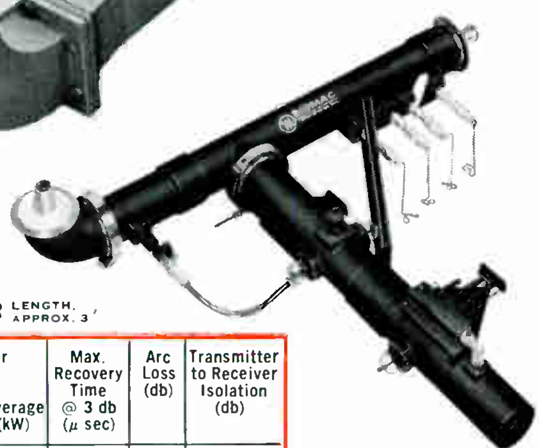

HIGH POWER COAXIAL LINE DUPLEXER LENGTH APPROX. 3'

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		Peak (Mw)	Average (kW)			
400-450	Balanced Duplexer	3	15	120	< 0.1	70
400-450	Branched Duplexer	3	5	100	< 0.1	60
850-950	Balanced Duplexer	2	15	100	< 0.1	70

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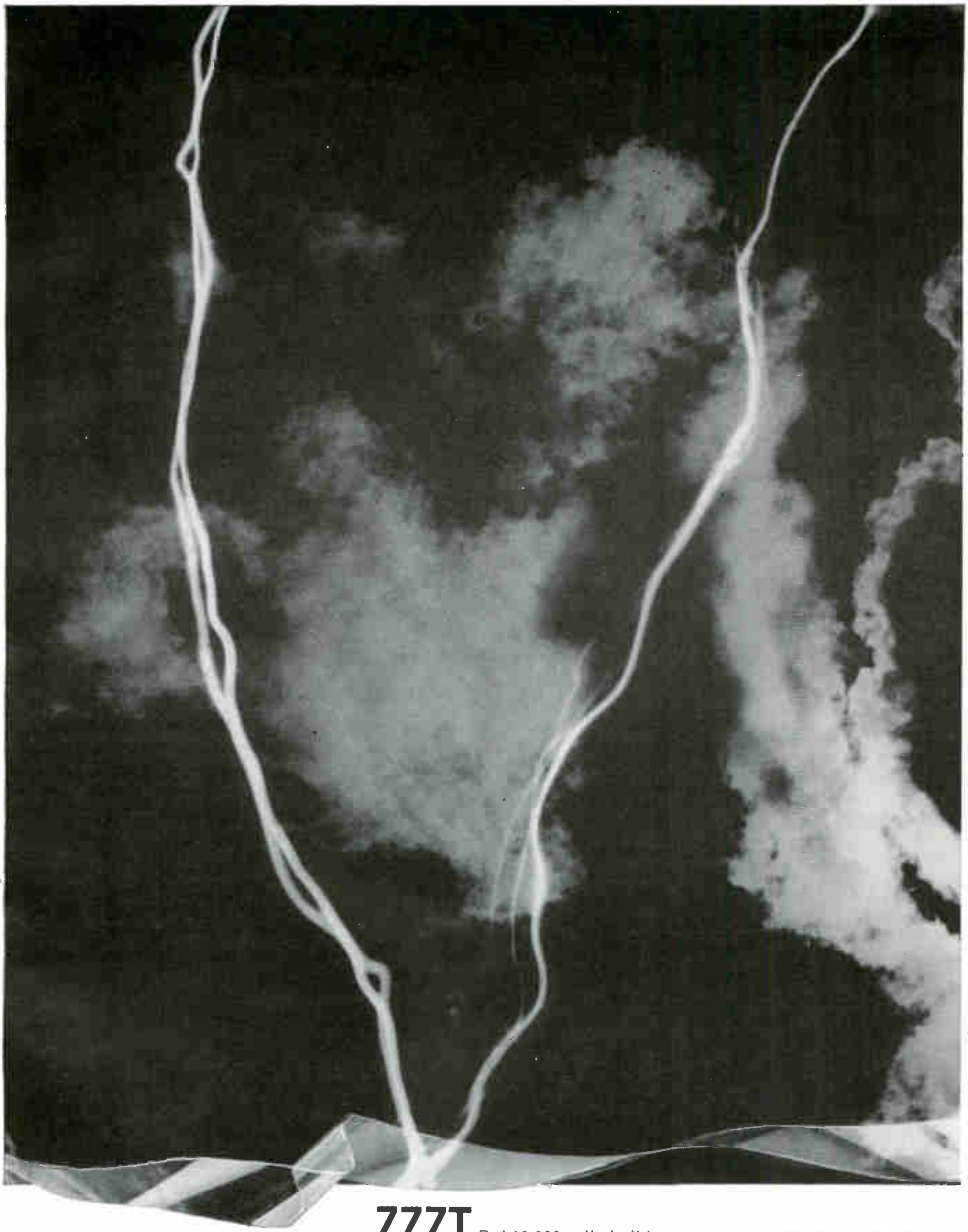


CIRCLE 73 ON READER SERVICE CARD

Laser Used to Confirm Physical Standards

Michelson-Morley experiment to be up-dated with laser

By THOMAS MAGUIRE
New England Editor

IN A WINE VAULT in a South Dartmouth, Mass., mansion, a team of MIT researchers headed by Charles H. Townes is preparing to explore the potentialities of the laser as a fundamental scientific tool of great precision and delicacy, and the wavelength of light as possibly the ultimate standard of length and time.

Prof. Townes will conduct the equivalent of an updated Michelson-Morley experiment with low-powered He-Ne lasers operating in the 1-micron range. Working with him are Associate Prof. Ali Javan, T. S. Jaseja, and John Murray. The laser work is associated with the MIT Research Laboratory of Electronics, which also sponsored the project which recently illuminated the moon by a laser beam.

PROFESSOR *Charles F. Townes heads the MIT research group that investigates the utilization of lasers for physical experiments and measurements*

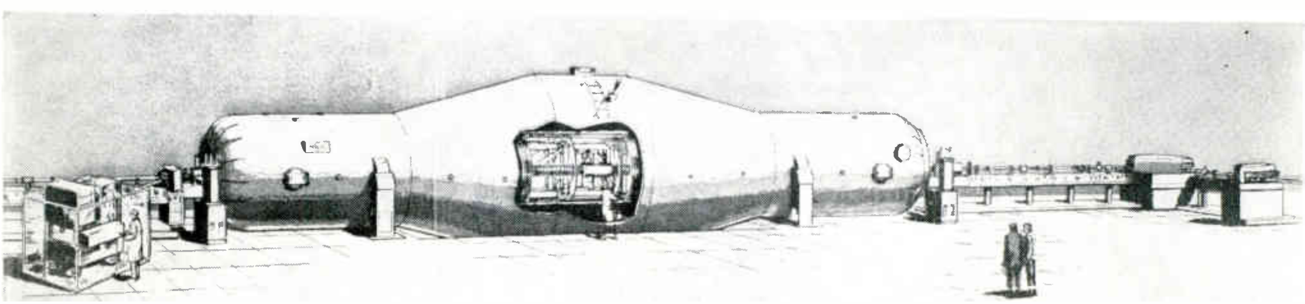
The experiment is one of a series of three proposed by Townes to help examine fundamental relations concerning length and time predicted by relativity theory. These experiments and others being carried out by the group at MIT will help determine achievable limits of precision of the optical maser, and could open the way to more precise standards of length and time.

Back in 1958, Townes, then at Columbia, used two ammonia-beam masers to do a refined version of Michelson's ether-drift experiment. The 1958 experiment, which gave further clear-cut support to special relativity over the ether theory, involved a comparison of the rate of oscillation, or the time scale, of two maser oscillators to an accuracy of one part in 10^{12}.

The one now under preparation at Round Hill would search for modifications in length resulting from the earth's orbital velocity, rather than changes in time as in the 1958 test. The third experiment proposed by Townes—one which he has no present plans to implement—would measure the ratio of changes in time to changes in length, by comparing the frequencies of two optical masers with mirrors of different reflectivities.

LASERS COMPARED—In the Round Hill experiment, see illustration on the cover, two optical masers—oscillating independently—are placed at right angles, with a half-silvered mirror at the junction of their outputs. Half of the beam output from one laser goes through to the photocell beyond,

Large Particle Accelerators to Universities



HIGH VOLTAGE *Engineering Corporation's $3-million 20-Mev tandem Van de Graaff accelerator, purchased during the last two months by the National Science Foundation and AEC for nuclear structure research at Rochester, Minnesota and Yale Universities, will produce stabilized and homogeneous accelerated ion beams at currents up to 25 microamperes, weighs 187 tons* *can you use the advantages of Kepco's*

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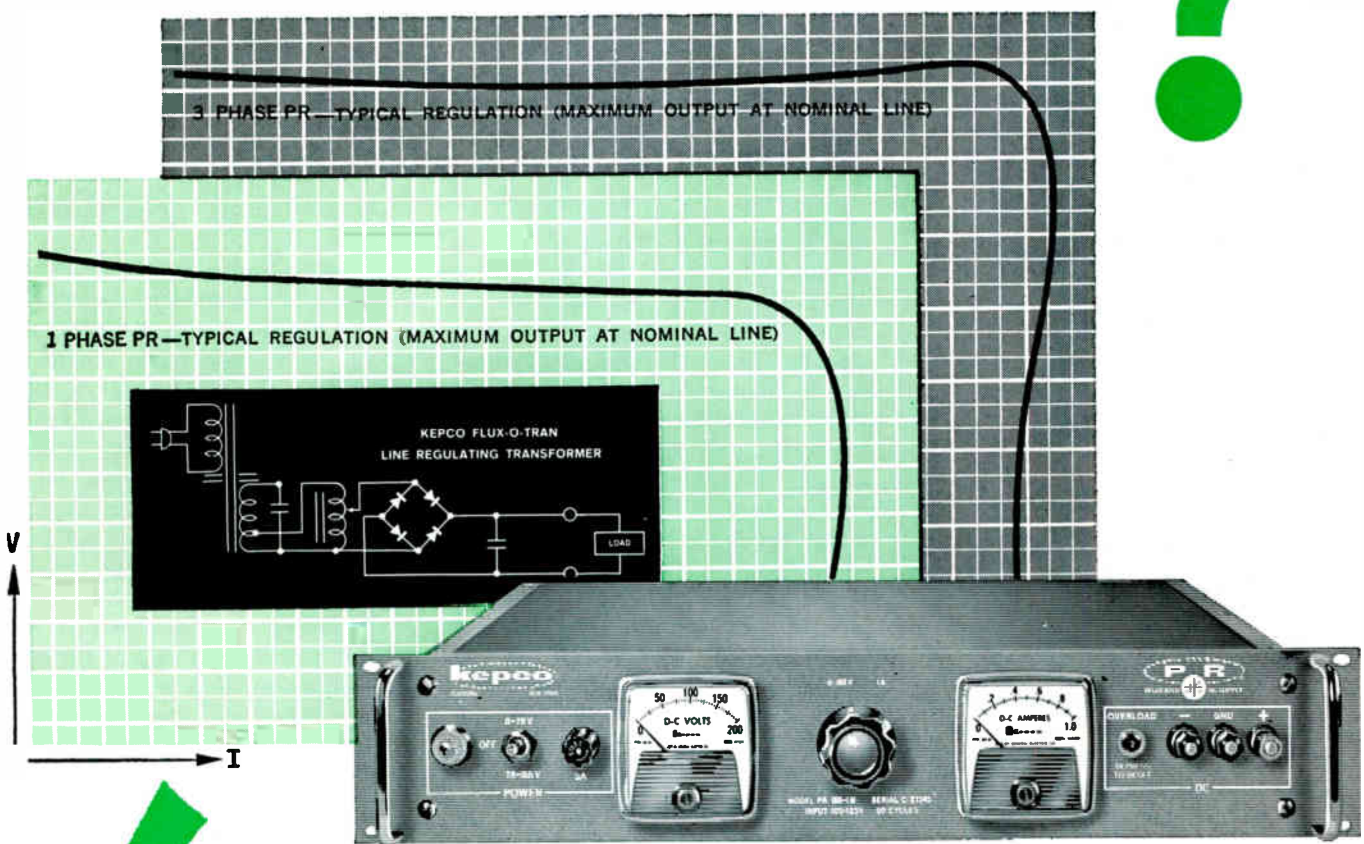

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VOLTS	0–7.5–15	0–15	0–19–38	0–38	0–40–80	0–80	0–78–155	0–155	0–165–310	0–310	0–20	0–40	0–50
AMPS	0–10	0–30	0–5	0–15	0–2.5	0–8	0–1	0–4	0–0.6	0–2	0–100	0–50	0–40
MODEL	PR 15–10M	PR 15–30M	PR 38–5M	PR 38–15M	PR 80–2.5M	PR 80–8M	PR 155–1M	PR 155–4M	PR 310–0.6M	PR 310–2M	PR 20–100M	PR 40–50M	PR 50–40
PRICE	$345	$495	$325	$475	$325	$450	$325	$430	$345	$430	$1,125	$950	$950

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FIRST PRACTICAL APPLICATION?

Although many strange and wonderful uses have been proposed for the laser, today it still is mainly an experimental device. One of the first fields where it may find a practical application is in checking and confirming physical standards of measurement (see also ELECTRONICS, Feb. 15, p. 84). The MIT team will use the laser's high precision to confirm Einstein's theory of relativity

and the other half is reflected off the mirror and dispersed in the surrounding air. Of the output from the other laser, half the beam is reflected into the photocell and half goes through the mirror and is dispersed in the air. Light from the two lasers is mixed in the photocell and the difference frequency is accurately determined by standard electronic techniques. After the frequencies are beat together and measured, the table will be rotated 90 degrees changing the orientation of the light paths with respect to the earth's orbital velocity, the difference frequency measured again, and any change in the effective optical path for the two can be detected. From this a precise determination can be made of the upper limit of "ether drift".

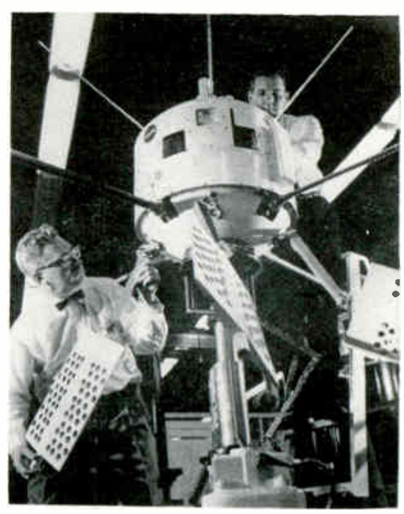
The Lorentz-FitzGerald contraction associated with the earth's orbital velocity is about 10^{-8} of the plate separation. Hence a frequency comparison of the two optical masers to a fractional precision $\epsilon = 10^{-15}$ would determine this contraction to one part on 10^7, about four orders of magnitude more accurately than previous techniques. Whether a precision as high as 10^{-15} can be obtained in practice is uncertain because of the effects of temperature variations, acoustic vibrations and other problems. However, it seems very likely that presently available precision can be markedly improved by use of optical masers.

Working at bedrock level in the Round Hill wine vault, the experimenters are trying to eliminate any acoustic vibrations that could cause variations of the optical maser frequencies. The experimenters hope to keep one laser mirror steady with relation to the other to the extent that they could detect a change in the length of the optical path amounting to 0.001 the diameter of an atom, or 10^{-11} cm.

"That means," says Prof. Townes, "being able to detect the ground shaking, or measuring the waves that rise when someone walks over the ground. Detection of a change of 10^{-11} cm. would give us an optical oscillator which would be constant to three parts in 10^{13}. We expect to be able to compare optical paths to that precision, which would give us an accuracy of one part in 3×10^4 in examination of the Lorentz-FitzGerald contraction, about two orders of magnitude more accurate than previous measurements. Without rotation, and over brief periods of time, the lasers do show that accuracy. We hope that, with rotation, the same accuracy will be obtainable."

To minimize temperature variations from excess heating, the

How Noisy Are Stars?



ENGINEERS EXAMINE *test model of the S-52 satellite, a joint U. S.-United Kingdom project to measure galactic noise, ozone distribution and micrometeoroids. Westinghouse Electric is building it for NASA; British scientists will provide instrumentation*

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You can take advantage of this material's low dielectric constant (nominally 1.6) in two ways:

For a given conductor size, the outside diameter and cable weight can be significantly reduced; or, for a given outside diameter, the conductor can be made larger for added mechanical strength and lower electrical losses.

In either case, foamed FEP constructions offer you the unmatched insulating reliability of TEFLON resins—the high use temperatures (400°F. continuous), the nonflammability, the chemical inertness under all operating conditions. In addition, outgassing losses in vacuum environments are held to a minimum.

Why not find out more about this new development in coaxial cable insulation and the new tailored performance and reliability it makes available to you. Write to: E. I. du Pont de Nemours & Co. (Inc.), Div. E-322 63TE, Room 2526 Nemours Bldg., Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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lasers are run at low power, and emit only a fraction of a milliwatt.

They are placed on a heavy block of aluminum, which is suspended from its four corners by aircraft shock cords. These meet in a metal plate which can be rotated around a rigid rod connected to ceiling beams. The aluminum table—effectively isolated from ambient vibrations—can be rotated when a small motor is actuated and tugs on it gently with thin rubber bands.

Government Underwrites New Biomedical Center

CHICAGO—U.S. Public Health Service is financing its first biomedical engineering research center at Northwestern University, with a $1.3-million grant extending over the next five years. Part of the funds will expand labs for physiological control systems, transducers and biomedical instrumentation, and also help accelerate computer applications to medical research. PHS has indicated it may also establish similar centers at other universities. About 10 schools have biomedical engineering programs.

Human Fly

UPSIDE-DOWN MAN *demonstrates possible space use for ceramic magnets that can have their poles reversed by switching circuit. Shoes can be used by astronauts during weightlessness in space. Magnets, developed by Westinghouse Electric, are being evaluated also for remote control, relay, memory and other applications*

REPORT TO THE INDUSTRY

At introduction a year ago, the industry's reaction was — "It's impossible at that price!" Now, the outstanding performance reliability and value of the Series 62 potentiometer is an historical fact, backed by extensive in-field and laboratory evaluations.

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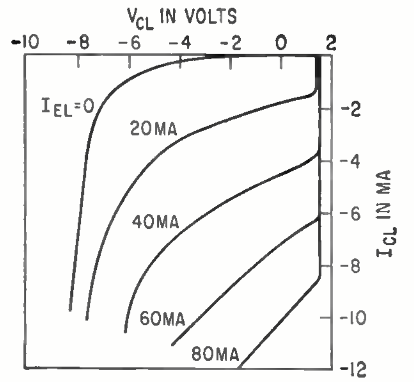
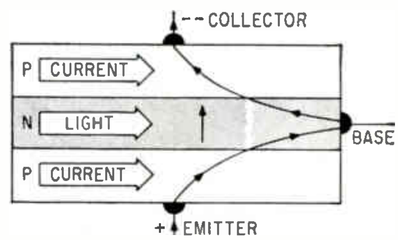
Optical Coupling: Key to Design Freedom

Photons hold answer as signal carrier in three important areas





EXPERIMENTAL *optical-coupling transistor structure is examined by IBM's R. F. Rutz (standing) and R. C. McGibbon. Configuration uses light energy to create electron-hole combinations as photons are absorbed near junction between base and collector. Graph shows current-voltage characteristics of three-layer device*

DETAILS of IBM's experimental gallium arsenide transistor, which uses optical coupling between diffused *p-n* junctions, was recently reported by company's R. F. Rutz (ELECTRONICS, Mar. 8, p 7).

Schematic drawing of the device is given in diagram, along with common base current voltage characteristics. Rutz says wider base region can be used in this type of configuration, which means lower base resistance.

Primary disadvantage right now is low current gain. But Rutz says improvements are possible by removing the highly light absorbing, heavily doped surfaces of the *P*- regions and adding reflecting coatings.[1]

Several three-layer *pnp* structures were fabricated by diffusing zinc at 850 C to a depth of approximately 2 mils into a 6-mil thick wafer of *n*-type gallium arsenide, tellurium doped, with a room temperature net impurity concentration of approximately 3×10^{17} atms/cms.[8]

From the wafer, small square chips of 10 mils to a side were cut and ohmic contacts were alloyed to the three regions. Width of the base region is about 2 mils.

The optically-coupling transistor may be useful as a fast inverter in the common connection, and as an impedance transformer. Devices were fabricated by R. McGibbon, and unit has been operated as a one megacycle oscillator by C. Lanza.

Greater band gap and potentially greater mobility of gallium arsenide over silicon and germanium has been generally known for some time. During the past few years, gallium arsenide compounds have been examined for potential use in high-frequency and high-temperature devices.[2]

PHOTONS—Key to new freedom in transistor design is fact that gallium arsenide differs from semiconductors like germanium and silicon in that light (photon) energy is produced in former, charged current carriers are produced in latter two.

Not only do gallium arsenide compounds offer possibility of supplying a light source[3], photon injection mechanism can be used as the transport between input and output junctions of solid-state devices, and gallium arsenide compounds have potential in the laser area.

Light, used to carry signals, can open up new horizons for diodes and transistors[4, 5, 6], integrated solid-state networks[7], optoelectronic

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(1) R. F. Rutz, Transistor-Like Device Using Optical Coupling Between Diffused p-n Junctions in GaAs, *Proc of IEEE*, Mar., 1963.

(2) M. F. Tomaino, What Lies Ahead for Gallium Arsenide?, ELECTRONICS, Feb. 17, 1961, p 144.

(3) Will Gallium Arsenide Provide New Electronic Light Source?, ELECTRONICS, Dec. 28, 1962, p 52.

(4) L. K. Anderson, The PIN Junction Photodiode as a Detector of Light Modulated at Microwave Frequencies, Bell Telephone Labs, Murray Hill, N. J. (1963 Solid-State Circuits Conf, IEEE).

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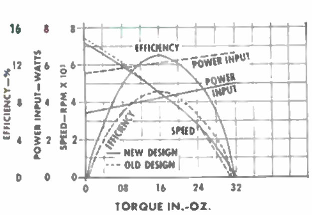
(6) J. R. Biard et al, GaAs Infrared Source for Optoelectronic Applications, Texas Instruments, Dallas, Texas (1963 Solid-State Circuits Cof, IEEE).

(7) M. F. Wolff, Advances in Microminiaturization, Special Report, ELECTRONICS, Feb 15, 1963, p 57, 59.

(8) F. H. Dill, Jr., Gallium Arsenide Injection Laser, Thomas J. Watson Research Center, IBM Corp, Yorktown Heights, N. Y.

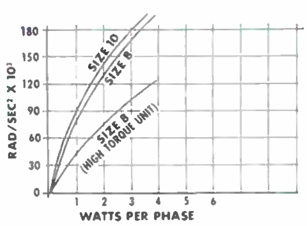
(9) N. Holonyak Jr., Active Region in Visible-Light Diode Laser, GE Semiconductor Products, Syracuse, N. Y., ELECTRONICS, Mar 1, 1963, p 35.

Clifton Precision announces 4 major improvements in Servo Motor performance



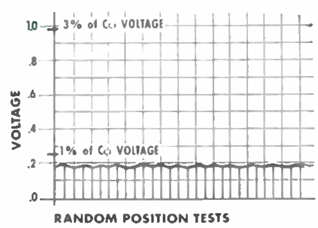
These motors provide more torque for considerably less power input. This results in a more efficient motor as well as a cooler running motor.

In addition, single phasing considerations have not been sacrificed.



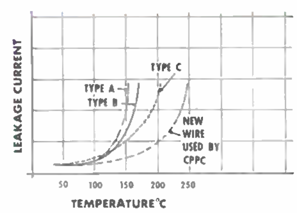
Acceleration is increased to 160,000 rad/sec² at between 2 and 3 watts/phase. Up to 200,000 rad/sec² is possible under certain conditions.

This is such an improvement that in certain motor-generator requirements, a new CPPC servo motor will now suffice.



Whereas starting voltages have been specified at 3% of control phase voltage, we can now guarantee 1% and a great deal more uniformity.

Furthermore, starting voltage of these motors has been exhaustively tested so that all starting characteristics can be accurately predicted.



New slot and magnet wire insulation allows much less current leakage at high temperatures.

In addition, new lubricants and new impregnation enable these motors to withstand 200°C plus. Solderless (all welded) connections are now incorporated in our servo motor line.

For full information: Sales Dept., 5050 State Rd., Drexel Hill, Pa., 215 MA 2-1000, TWX 215 623-6068—or our Representatives. See and discuss these motors in our suite, Barbizon-Plaza Hotel during the IEEE Convention, New York City, March 25-28.

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circuits, and laser action at higher pulsed current[8, 9].

Mechanism of photon emission from gallium arsenide structures is still not clearly understood. But phenomenon is being explored at many laboratories, including General Electric, RCA, MIT Lincoln Labs, Texas Instruments, Sperry Rand, and Hewlett-Packard Associates.

An exciting possibility for photon injection is foreseen in integrated circuit blocks. The photon mechanism could solve knotty interconnection problems that now seem to be the bane of microelectronics.

Capacitor Wafers Now in Production

TWO TYPES of single-layer ceramic capacitor microelements for micromodules, recently announced by Cornell-Dubilier are their temperature-compensating capacitor, Type MMC, and general purpose Type MMG. Each has a capacitor element made from a notched ceramic wafer 0.310-in. sq and 0.010-in. thick with fired silver terminations.

Micromodule circuit is formed by stacking capacitor wafer with resistor, inductor, transistor and semiconductor microelements in square frame of 12 wires, 3 to a side. Encapsulated module forms a unit 0.36-in. sq, height depends on number of stacked microelements.

Temperature-compensated capacitor element is rated at 100 v d-c working, and has capacitance range of 4.7 to 400 pf. Tolerances are either ±5, ±10, or ±20 percent. The Q factor or ratio of pure reactance to effective resistance is 1,500 minimum up to 100 pf. The Q value decreases linearly above 100 pf to minimum of 1,000 at 400 pf.

The general-purpose wafer also is rated at 100 v d-c working, has capacitance range of 300 to 5,000 pf. Unit has maximum dissipation factor of 2 percent.

Engineers Will Study Laser at IEEE

LASER, developed by General Telephone & Electronics Laboratories, will be displayed at IEEE show. Long-life, sealed gas laser

is now available to commercial and military customers through Microwave Device Division of Sylvania.

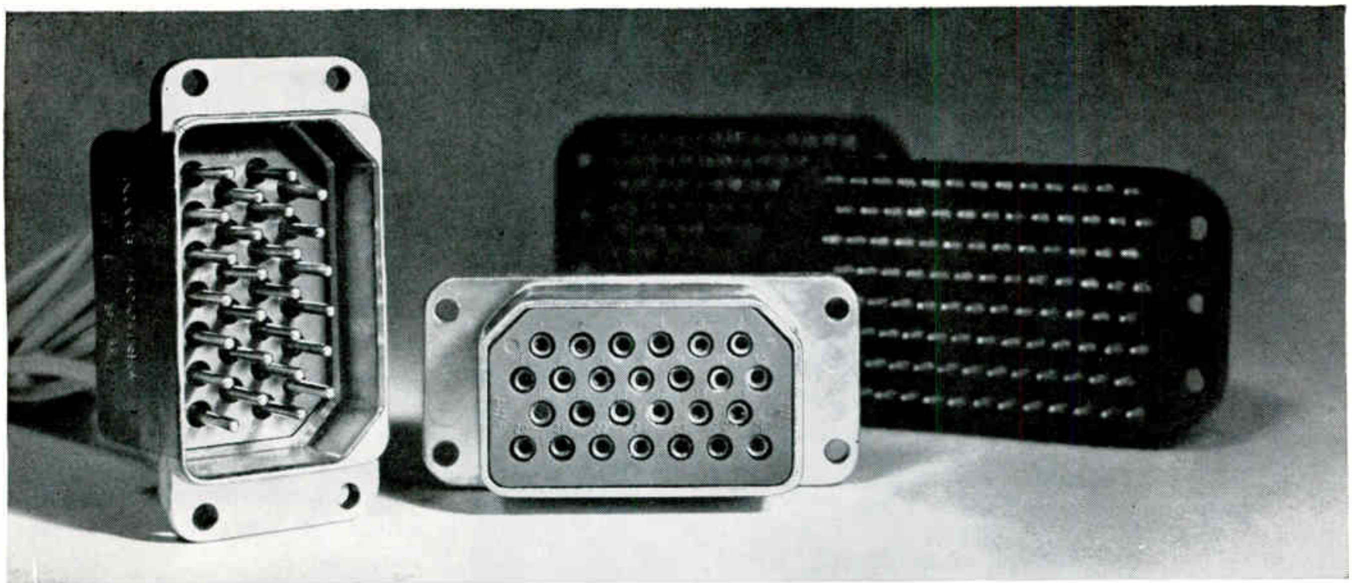
Single laser, as a communication source, may some day carry as much information as all communications channels now in existence. Scientists are now investigating laser uses for precision drilling and welding. Source of heat is as high as 100 million watts per square centimeter.

Power Amplifier Meets Satellite Requirements

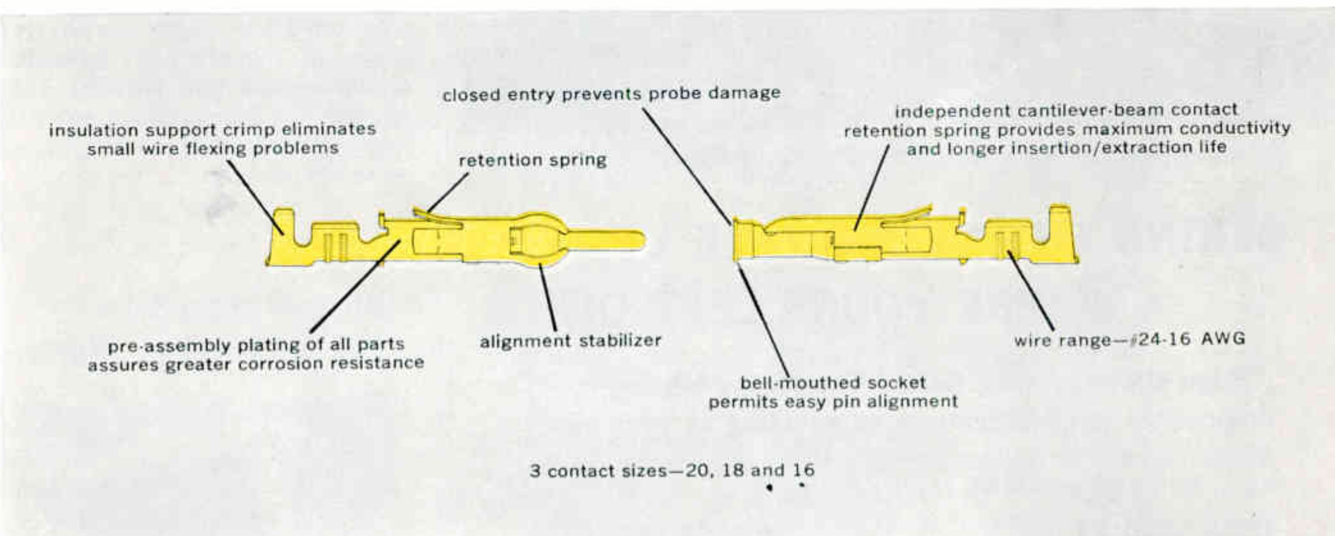
IN TRAVELING-WAVE tubes, bulk of overall weight is usually contained in magnet structure which focuses the electron beam along the length of the tube. Cathode design is a critical factor that can affect tube life. These two considerations were carefully evaluated in designing the key power-amplifying device of Project Relay Communications Satellite, RCA Type A1245.

The twt developed for NASA solved the weight problem by incorporating platinum-cobalt ring magnets for the magnet focusing structure and overcame problems of cathode-current emission density and low operating temperatures. Relay's twt employs a helical slow-wave circuit and a periodic permanent-magnet focusing system.

Tube produces a minimum r-f output of 11 watts at a gain of 33 db over its 4,050 to 4,250 megacycle frequency band. Overall efficiency of the tube is 21 percent, according to company. High efficiency is achieved in the tube by operating



What's unique about these connectors?



This stamped and formed contact!

This is the AMPin-cert* TYPE III pin and socket contact—an exclusive development of AMP Incorporated. With it, you can now get reliable connector performance at a much lower initial cost . . . at the lowest applied costs in the industry. Consider these facts:

- performance characteristics conform to all dimensional and mechanical requirements of MIL-C-8384A.
- contacts are crimp, snap-in type for assured uniformity and quick, easy connector assembly.
- strip-mounted, reel-fed termination with our automatic crimping machine provides rates of 1,600 uniformly crimped contacts per hour.
- contacts are available for a wide range of housing block types and configurations—including AMPin-cert "M" (MIL-C-8384), "D" and "D-D" and "W" Series Connectors.
- Standard AMP Contact Plating: .00003″ non-porous gold over .00003″ nickel, special platings available on request.

Put an end to solder-pot uncertainties, hit-or-miss connections, production slow-ups due to time-consuming inspection steps. Get consistently reliable connectors and at the lowest applied costs in the industry. Specify AMPin-cert TYPE III contacts. There is no equivalent! Write today for more information.

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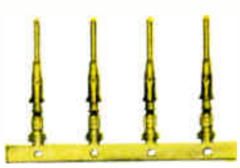

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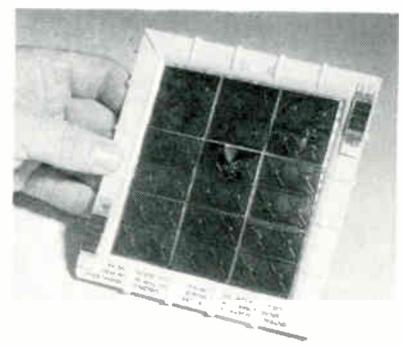
the collector at a voltage depressed considerably below helix voltage. Company says forced air cooling requirements are eliminated by conducting the heat from the collector to a heat sink.

Use of the RCA-developed dark heater further reduces the operating temperatures of the heater to less than 1,000 C, a value well within limits required for long life and good reliability. Extensive cycling tests of heater-cathode assemblies determine effects of repeated on-off cycling. Company reports no changes after an accumulated 100,000 cycles which is equivalent to 100 years of satellite operation.

Douglas Smith, vice president and general manager of RCA Electron Tube Division, said the 3.5-pound traveling wave tube used in Relay is the key power-amplifying device of the satellite's wideband communication transmitters. Tube measures 18.5 inches long and 2.25 inches in diameter, and is cylindrical in shape.

Rugged Little Solar Power Converter Works



EXPERIMENTAL *solar converter was successfully tested under actual space conditions*

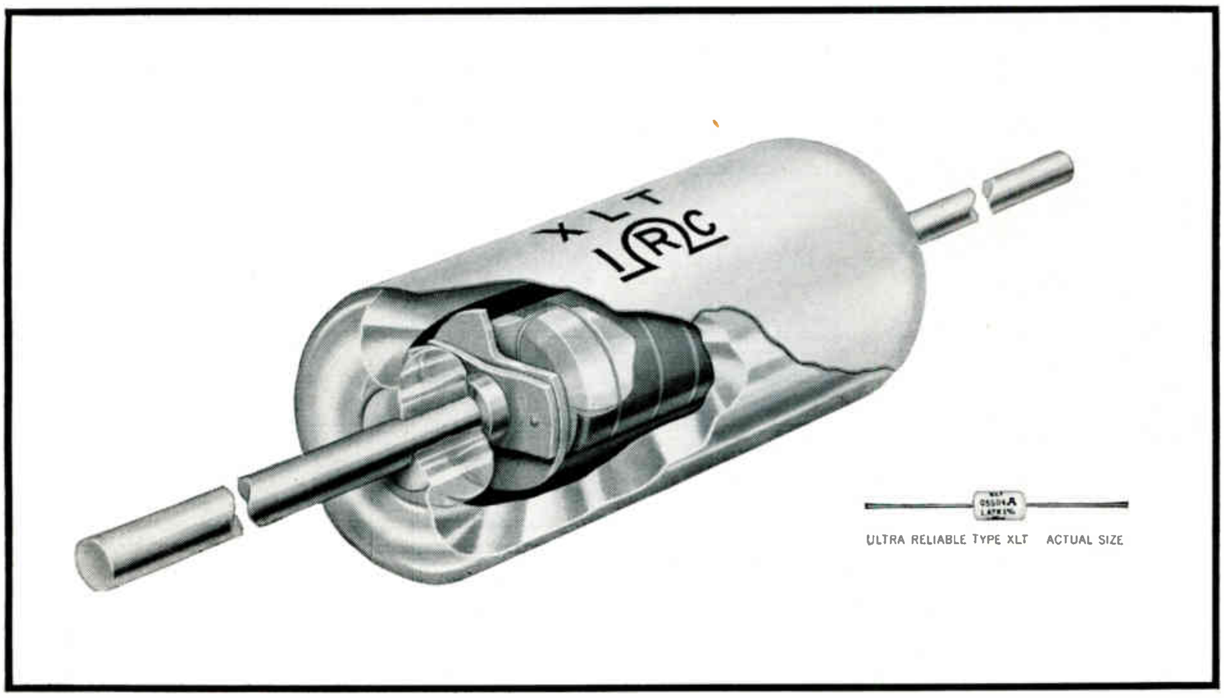
AIR FORCE announced recently that it has successfully test-flown in a satellite a radiation-resistant thermoelectric converter. Such converters, it was reported, will probably be cheaper and lighter than silicon solar cells.

The experimental model consists of 36 elements sandwiched between 2 thin metal plates. One plate collects energy, the other dissipates waste heat. Elements, measuring

THE RESISTOR WITH A 3 YEAR HEADSTART ON

MIL-R-55182

NEW RELIABILITY SPECIFICATION



This is the resistor that pioneered Documented Reliability . . . forerunner of the MIL-R-55182 concept of component reliability. It was designed to meet the most stringent reliability standard ever set forth, the standard adopted by the Military in 1958 for critical missiles.

MISSILE RELIABILITY

To date, the ultra-reliable XLT resistor has been tested for more than 260,000,000 unit hours (65,000 units for 4,000 hours), demonstrating a failure rate of 0.00036%/1,000 hours (1/16W., 25°C, proved to 60% confidence, failure defined as $\Delta R > 0.5\%$).

HIGH STRESS RELIABILITY

Under higher stress conditions, IRC has accumulated 35,100,000 unit hours, demonstrating a failure rate of 0.0027%/1,000 hours (1/8W., 100°C, proved to 60% confidence, failure defined as $\Delta R > 2\%$).

MIL-R-55182 RELIABILITY

MIL-R-55182 reliability levels are established at 1%, .1%, .01% and .001% at $\Delta R > 2\%$. Testing to this specification, IRC has already accumulated 6,200,000 unit hours WITH NO FAILURES . . . and is still going, demonstrating a failure rate of 0.015%/1,000 hours (1/8W., 125°C, proved to 60% confidence).

IRC's experience with the ultra-reliable XLT is now being applied to other types of IRC precision film resistors. If you want a headstart on MIL-R-55182, write: International Resistance Co., Philadelphia 8, Pa.

IRC

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0.04 × 0.04 × 0.1 inch, are made of *p*-type zinc antimonide and *n*-type lead telluride. The converter was developed by General Dynamics.

Air Force Reviews Materials Programs

STUDIES in materials, ranging from the development of new metal alloys for aerospace applications to investigations of high-temperature fabrics for re-entry parachutes, are described in publications just released to science and industry.

Reviews cover reports on materials programs conducted during the period from July 1959 to June 1960,[1] and during the period from July 1960 to June 1961.[2]

REFERENCES

(1) D. J. Tate, A Review of the Air Force Materials R & D Program, 193 p, June, 1961, AD 270267 OTS, U. S. Dept of Comm, Wash. 25, D. C., $3.

(2) J. J. Banks and D. J. Tate, A Review of the Air Force Materials R & D Program, 210 p, Mar. 1962, AD 276 709 OTS, U. S. Dept of Comm, Wash. 25, D. C. $3.50.

High-Purity Iron Prepared for Study

RODS of super pure alpha iron single crystals, up to several inches in length, have been pulled for advanced materials research. Resistivity values for these crystals, a function of their purity, are claimed to be the highest ever reported, according to Materials Research Corp., Orangeburg, New York.

The iron crystals will be used to obtain more precise information about the electronic structure of the material, radiation susceptibility, corrosion behavior, and investigation of the mechanical properties of iron.

Rods are made by purification of starting material in the MRC electron beam zone refiner. Iron is converted to single-crystal form by straining and heat treatment.

Major objective of this materials program includes further development of techniques for preparation of crystals having reproducibly good structure and properties. Program is sponsored by Atomic Energy Commission.

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Measure microvolt signals accurately... in the presence of high common mode noise!

The bench-proved and system-proved DY-2401A Integrating Digital Voltmeter from Dymec is today's most accurate instrument of its kind for measuring low-level signals in the presence of high common mode noise. It's today's best digital voltmeter buy!

Ten volts of common mode noise on the signal results in a mere one microvolt error. No other digital voltmeter can match that performance. Dymec accomplishes this remarkable performance in the DY-2401A with two techniques: Guarding of the entire measuring circuit, which physically breaks the ground loop currents that circulate in systems with more than one ground; and true averaging of the signal over the sample period, which solves the problem of noise superimposed on the signal. Averaging alone provides virtually infinite rejection of 60 cps and 400 cps noise. The DY-2401A is not dependent on passive input filtering responsible for slower measuring speed.

Low-level measurement . . . High sensitivity of the DY-2401A, even in the presence of noise, offers a 5-digit range of 100 mv full scale. Add the DY-2411A Guarded Data Amplifier and you have an unequalled ±10 mv full scale 5-digit range. Compare this with any other digital voltmeter . . . and consider your applications in measuring the outputs of thermocouples, strain gage bridge transducers or other millivolt level dc voltages.

For 10 mv full scale sensitivity

DY-2411A Guarded Data Amplifier adds the ±10 mv full scale 5-digit range to the DY-2401A Voltmeter, with overranging to 30 millivolts and constant 10,000 megohm input resistance. It preserves the guarded measurement features of the 2401A, providing 134 db effective CMR. Gain settings of +1, +10 and bypass are programmed by simple ground closures, with no effect on common mode rejection.

DY-2410A AC/Ohms Converter . . . provides floated and guarded broadband ac voltage and resistance measurements, with full programmability. AC measurements 50 cps to 100 kc, five ranges including 0.1 v rms full scale, 300% overranging on four most sensitive ranges, 110 db common mode rejection at 60 cps when used with the 2401A. Resistance measurement, 100 ohms to 10 megohms full scale in six ranges, with 300% overranging.*

COMPARE: DY-2401A, $3950
DY-2411A, $1150
DY-2410A, $2250*

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* Available also in ac-only, ohms-only models.

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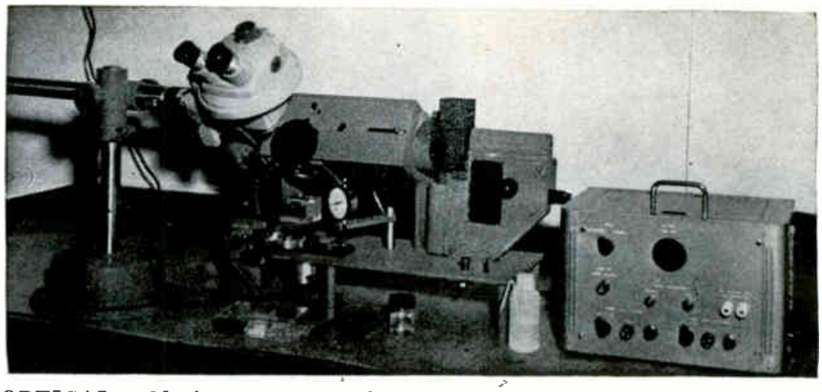


OPTICAL *soldering equipment includes carbon-arc lamp energy source and positioning jig for holding modules to be soldered*

Optical Soldering Promotes Automated Packaging

System packing density of 1.8 × 10⁶ components/ft³ achieved

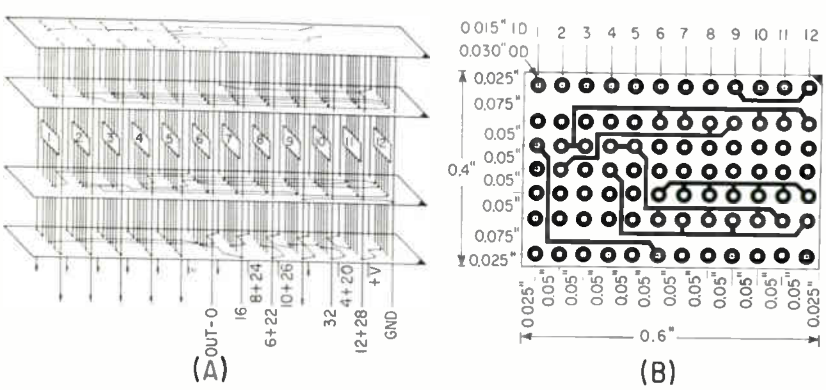
By GEORGE J. VETH
John Hopkins University
Silver Spring, Md.

NAVY RECOMMENDATIONS for microelectronic packaging are followed by an optical-soldering technique now being used to package a frequency-divider system. Density achieved is 120,000 circuits/ft.^{3}, incorporating 1.8×10^6 components. The frequency-divider system contains 35 circuits occupying 0.45 in.^{3}, weighs about 0.02 oz. A high power dissipation of 100 mw at 3.3 v however, must be worked on.

FLAT PACKAGING—The introduction of circuit flat packaging as well as the conception of integrated circuitry has given impetus to the technique described here. Presently, most integrated-circuit manufacturers do not use a flat package. However, manufacturers are busily investigating this approach. The industry would be wise to think ahead and standardize on one flat-packaging approach so as to provide the design flexibility needed to accelerate introduction of integrated circuitry into systems. The optical soldering technique described here can then lend itself easily to automation.

The frequency divider system was built using a configuration that packs 35 flat-package elements in three 12-element modules.

SETUP — Proper location of the 12-circuit elements between specially laid-out circuit boards is determined as shown in Figure 1A, which is an exploded view. The two circuit boards above the flat-circuit packages and the two below are actually compressed to form two multi-layer etched circuit boards. Each of the 12 elements is interconnected to other elements by means of the circuit boards and the flat connection wires molded into the circuit elements. Therefore, circuit elements are positioned so as to provide input-output locations defined by signal-flow requirements between elements.

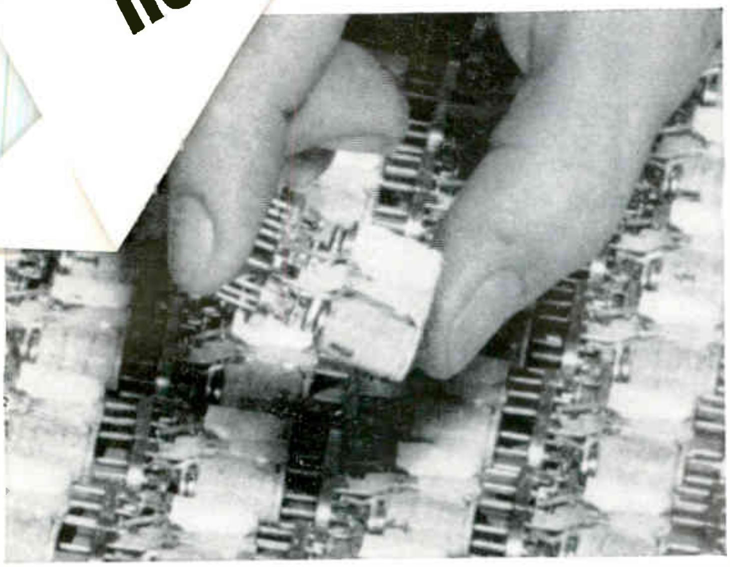


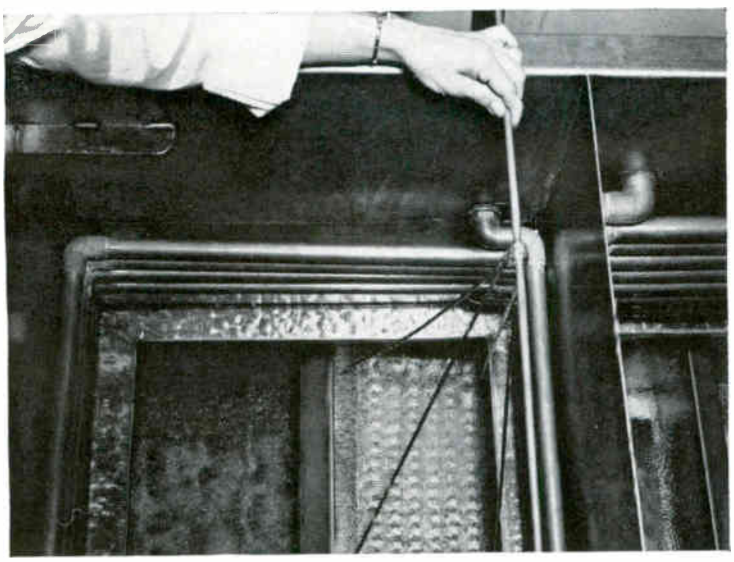
INTERCONNECTION *of circuit elements in modular configuration using lead wires and circuit boards is determined using overall orientation layout (A) and printed circuit layout (B)—Fig. 1*

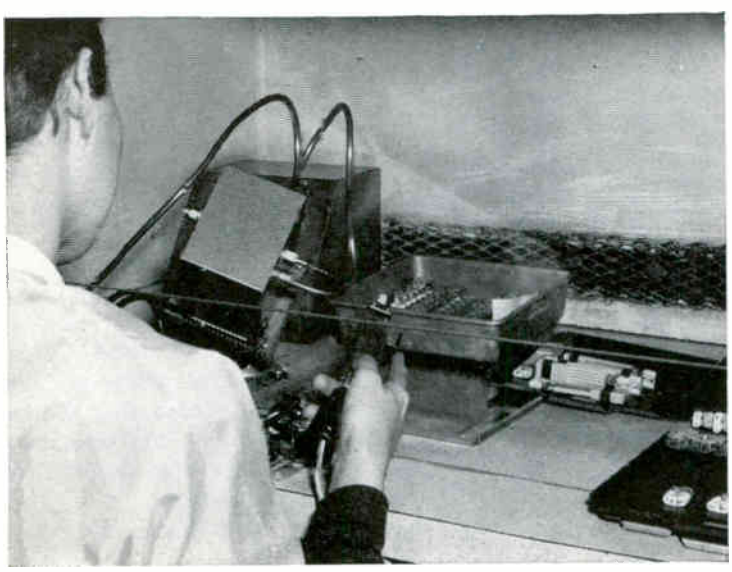
The basic circuit-board layout shown in Fig. 1B has holes for connection wires arranged in a rectangular pattern to accommodate a maximum number of wires. Since all holes have conductive lands, this master layout has a matrix of all circular lands. This simplifies printed-circuit artwork using black tape to layout interconnections.

Holes are made with a number 80 drill and countersunk as shown in Fig. 3. Countersunk configurations act as insertion guides for the lead

How Pott & Brumfield precision-cleans ile relays for top reliability!







PROBLEM: How to reduce an unacceptably high reject rate on critical "crystal-case" electrical relays (first photo) at Potter & Brumfield, Division of American Machine & Foundry Company... eliminate employee problems of headaches and nausea due to solvent vapors.

SOLUTION: A new cleaning system using "Freon" fluorinated solvents. "Freon" is an excellent selective cleaning agent. It removes solder flux, dust, lint and other contaminants, yet doesn't harm delicate relay parts. Also, "Freon" is virtually non-toxic, thus eliminating complaints about vapors.

In the cleaning process, a basket of relays is first given a 15-second ultrasonic bath in "Freon" TMC, then an ultrasonic bath in "Freon" TF for 15 seconds (second photo), and a 15-second rinse in TF vapor. Because of its low surface tension, "Freon" quickly penetrates the tiny spaces in the relays, allowing precision cleaning of delicate parts.

As a final cleaning step, the relay contacts are washed in a spray of "Freon" TF, while being electrically actuated (third photo). This assures that no particles are entrapped between the contacts. Only the high dielectric strength of "Freon" makes this operation possible.

According to Potter & Brumfield, the adoption of "Freon" solvent cleaning has upgraded product quality, meeting their critically high standards, equivalent to a 17% increase in production capacity while at the same time decreasing labor costs. They point out that "Freon" dries quickly and leaves no residue, and that its non-flammability and low toxicity let them operate without expensive ventilating equipment. They've found "Freon" solvents economical to use because they can be recovered in simple equipment for reuse... over and over again. Most important, "Freon" solvents have eliminated employee complaints on nausea and headaches.

• • • •

We'll be glad to give you help in selecting "Freon" solvents for use in your own cleaning operation. Just write on your letterhead to Du Pont, 2420E-3B Nemours Bldg., Wilmington 98, Delaware.

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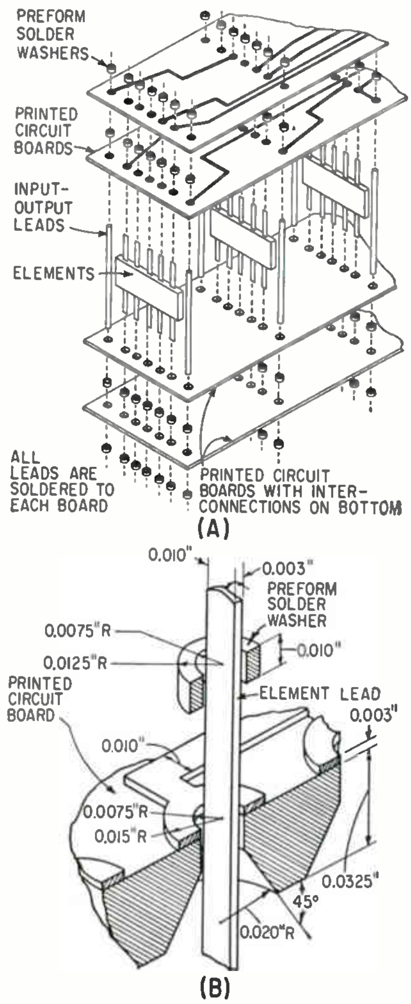
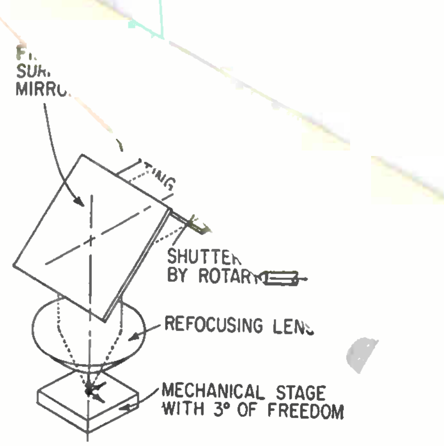
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY* wires and with soldering provides the tight fitting required for a rigid assembly.

FABRICATION—A module is fabricated as follows (Fig. 2):

- Circuit elements are connected to "bottom" circuit board with lead wires pushed into countersunk holes tightly enough to support elements
- "Top" multi-layered circuit board is placed in position to receive element "top" wires that are tightly inserted
- Assembly is placed in a board-holder jig
- Solder preforms are placed around wires using tweezers in top board and each row of holes is fluxed using a hypodermic needle with a low-viscosity, high temperature flux



EXPLODED VIEW of module shows assembly details (A). Close-up of soldered joint assembly shows how needed rigidity is supplied by countersink configuration that provides conical shape of solder mass (B)—Fig. 2



HOT-ENERGY SPOT is generated by optical soldering system and selectively applied to portions of joint soldered—Fig. 3

- Heat is applied with the optical soldering system to each joint in top board
- Module is inverted and procedure repeated for bottom board.

OPTICAL SOLDERING—Module fabrication is ultimately dependent on the optical soldering technique shown schematically in Fig. 3. The technique was developed to provide a controlled heat source requiring no physical contact with the solder joint. As shown, the system consists of:

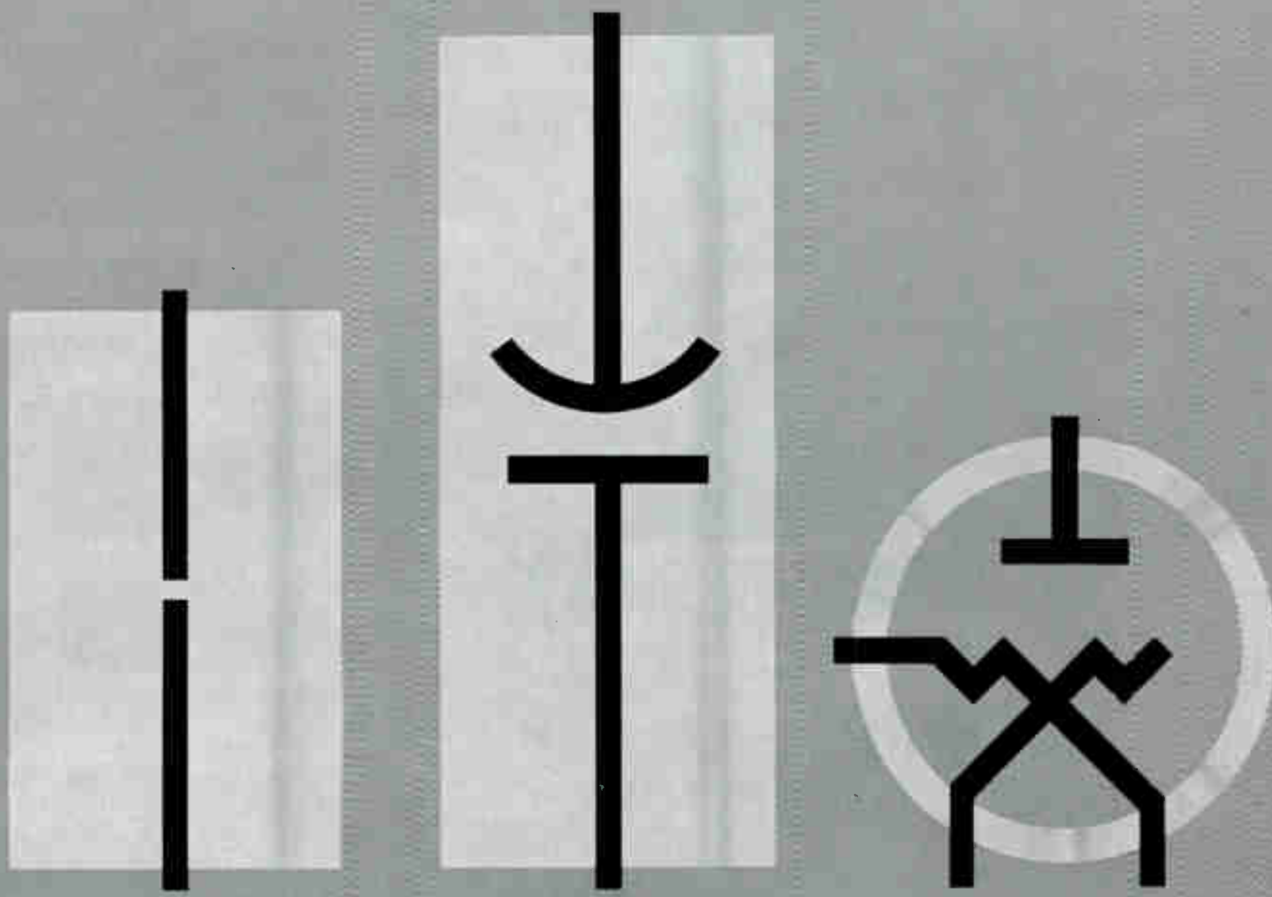
- A carbon-arc heat energy source
- Collimating and refocusing lenses for beaming heat energy onto solder joints
- Shutter and shutter control equipment for on-off control of heat-energy beam
- Mechanical stage with jigs for module positioning
- Optical aids for inspection and monitoring of soldering operation.

The module-positioning jig provides height of board needed to have system's hot spot pass through each solder joint. A filter is used with the optical viewing equipment to allow visually monitoring of each joint as it passes through the hot spot; jig is used to move module through hot spot.

AUTOMATION—A high degree of automation is foreseen for this process. The present "hand" operations—hole drilling, solder-perform placement, etc.—supporting the optical technique are too time consuming for other than the present laboratory procedure.

Features promoting an auto-

PACKAGING WITH COORS CERAMIC



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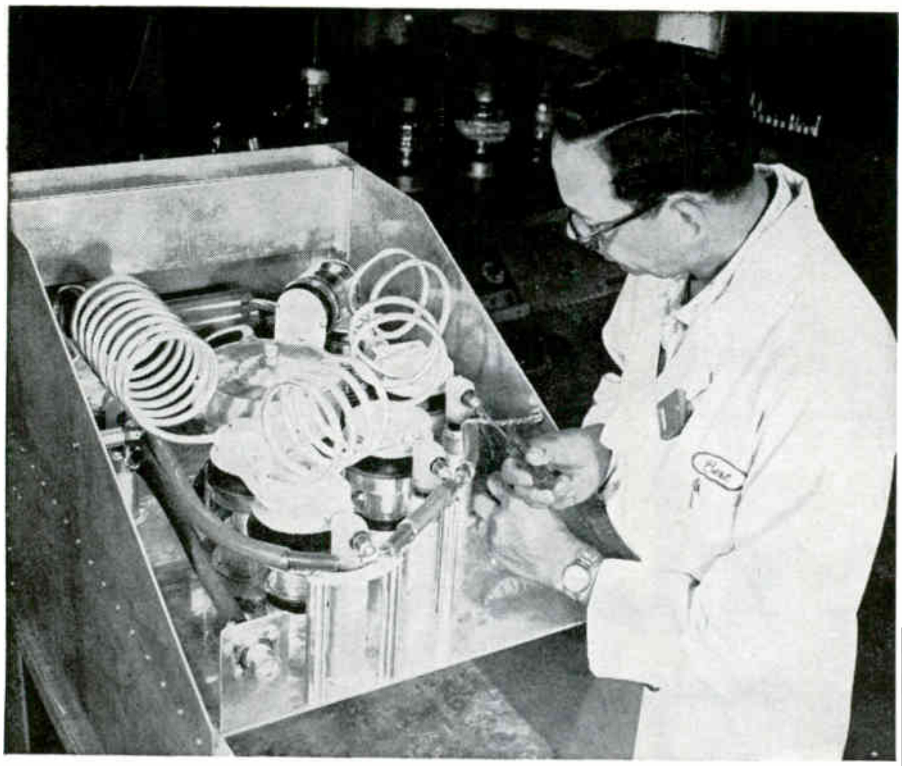
Coors Porcelain Co., Golden, Colo.

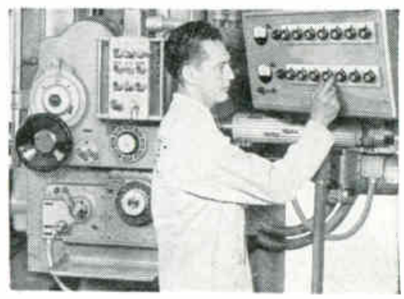
CIRCLE 93 ON READER SERVICE CARD



mated process include:

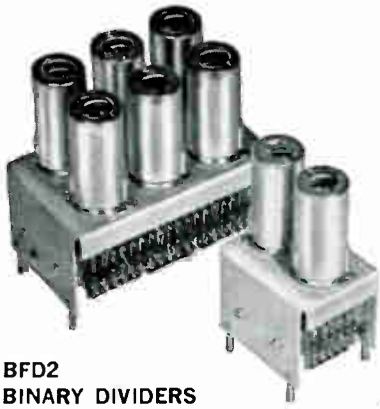
- Standardized hole matrix permits automatic drilling or molding of boards to eliminate drilling
- Hot-solder dipping of boards could leave enough solder material on copper lands surrounding board holes so as to eliminate individual solder preform placement. Along with this, continuous fluxing could be mechanized or a reducing atmosphere used
- Optical soldering technique could be servo-drive controlled.

Jigless Boring Helps Small-Lot Production



ROTARY *dial switches on spindle-head-mounted console control precise boring operations*

TWO SETS of direct-reading dials for preselecting horizontal and vertical movements permit fast set-up of boring operations for small-lot production jobs and eliminates the necessity for positioning jigs in assuring positioning accuracy. Used as part of the control system on the "Spirmatic Jigmils" produced by DeVlieg Machine Company, the rotary dial switches permit dialing-in of dimension settings in increments of 0.0001 inch, or if metric system measurement is being used, in increments of 0.001 mm. This is translated to horizontal movement of machine's table and vertical movement of machine's spindle head when operator depresses a pushbutton. While machine completes one operation, operator dials next move to duplicate blueprint dimensions on workpiece. Control system is entirely electronic using transistor circuits. A full zero offset is provided to permit operator to set zero or datum point at any point within control system's positioning range. Provision is made to switch to mechanical programming for automatic work.



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FG-F (FLAT CAN SERIES)
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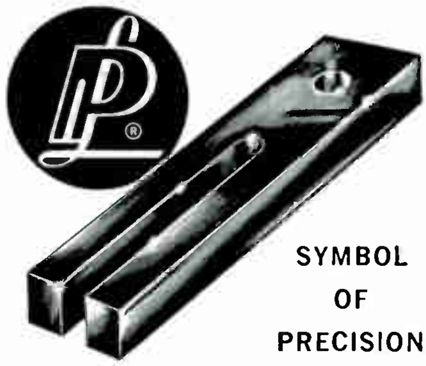

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William J. Kennedy
Sales Manager
shown 1/25 actual size
Model 9200
Coaxial Termination
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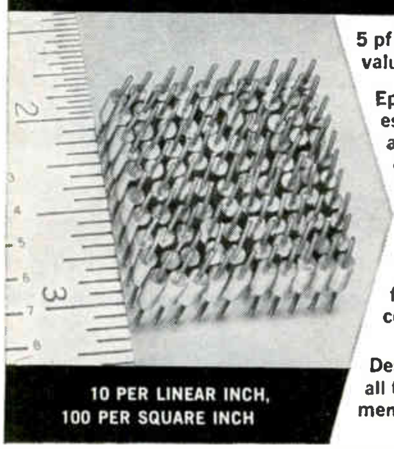

5 pf to 470 pf in 19 values, 200 WVDC

Epoxy molded for highest reliability and performance—less than 7½% capacitance change from −55°C to +125°C

FEATURES:

Standardized size for high density cordwood packaging

Designed to meet all the requirements of MIL-C-11015

The DECI-CAP is the latest addition to Nytronics' DECI Series—a series that does consist of inductors, capacitors and resistors in a uniform envelope to facilitate point-to-point assembly in cordwood, printed circuit and other high density module assemblies.

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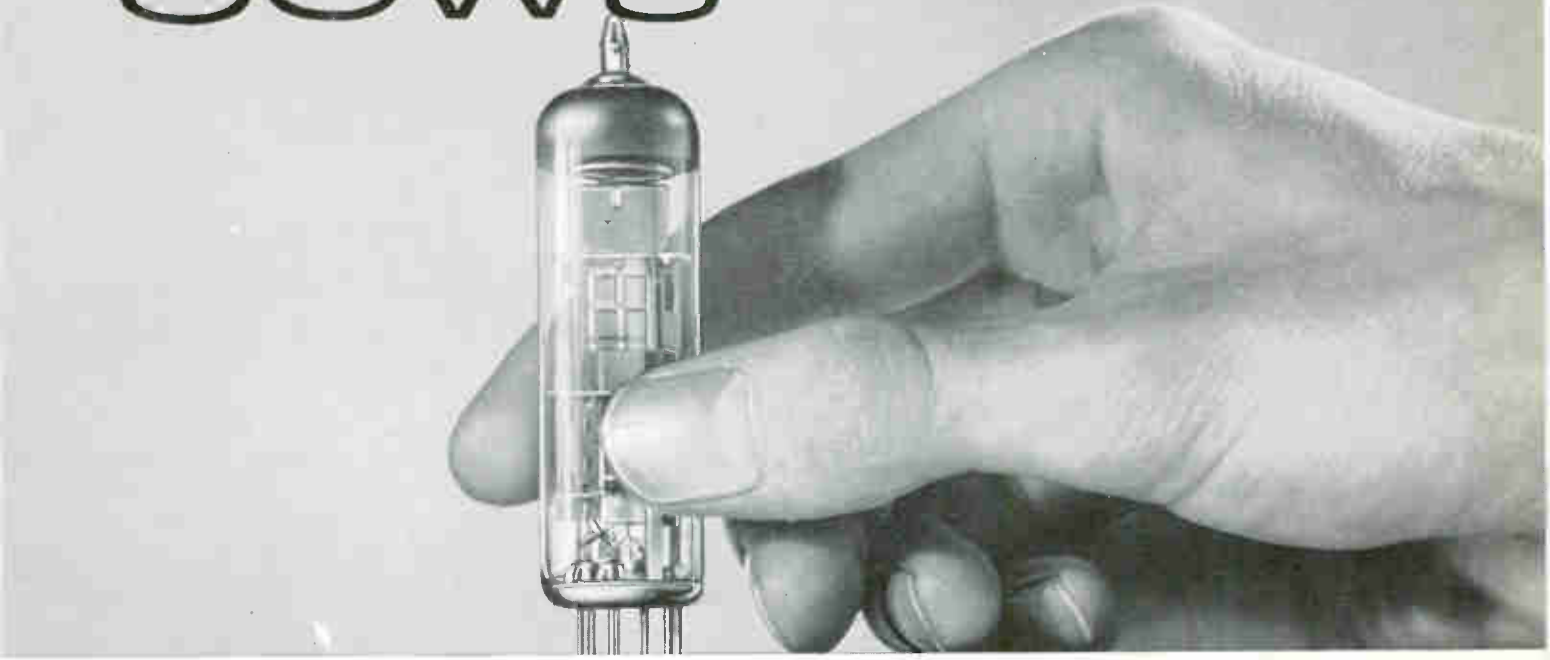
ECL86

6GW8



COMBINED HIGH MU TRIODE AND 9 WATT PENTODE

High sensitivity, coupled with high output power make the ECL86 the ideal tube for audio amplifiers. The high sensitivity of this tube stems from a triode amplification factor of 100 combined with a pentode slope of 10 mA/V. A single ECL86 will give an audio output of 4W (B+ = 250V), and two in push-pull will provide 14.3W (B+ = 300V).

CHARACTERISTICS

Pentode Section

g_m	10	mA/V
P_p	9	W
r_p	48	kΩ
E_b	250	V
E_{c2}	250	V
E_{c1}	—7·0	V
I_b	36	mA
I_{c2}	6·0	mA

Triode Section

μ	100	·
g_m	1·6	mA/V
r_p	62	kΩ
E_b	250	V
E_c	—1·9	V
I_b	1·2	mA

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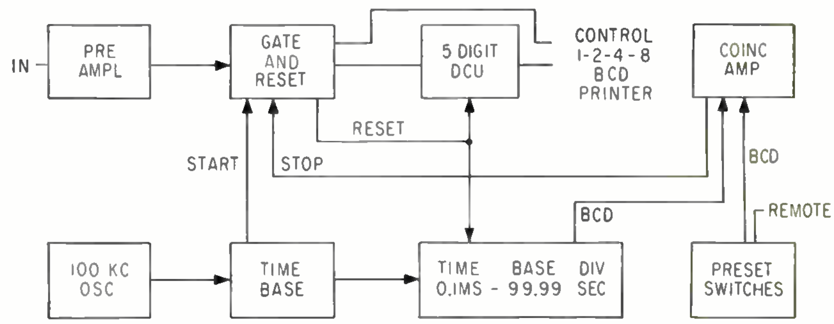
Counter Simplifies Quantity Measurement

Translates one function of time into another and displays it

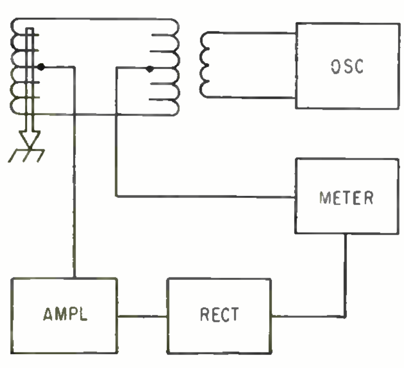


RECENTLY announced by Computer Measurements Co., 12970 Bradley Ave., San Fernando, California, model 702A variable time base frequency counter provides direct readout of unknown quantities by translating one function of time into another function of time. Frequency range is 1 cps to 300 Kc, sensitivity is 5 mv rms from 10 cps to 30 Kc and 100 mv rms from 1 cps to 300 Kc, input impedance is 100,000 ohms shunted by 50 pf and readout is 5-decade (vertical columns of incandescent lamps). Remote programming is available as well as a 1-2-4-8 BCD 5-digit printer output. One example of use is determining fluid flow rate. If a transducer provides 250 pulses per gallon of flow, and n equals gallons per minute, then $250n$ could be displayed if the counter is gated for 60 seconds. Therefore, n could be displayed directly if the counter is gated for 60/250 seconds, or 0.24 second. Better resolution could be obtained by using a 2.4 or 24 second gate and shifting the decimal point. Operation is shown in sketch. The input signal is fed to the preamplifier and shaped. The signal gate is controlled by start and stop signals from preset time base. When started, input frequency is counted by decade counting units (DCU) until stop pulse arrives.

CIRCLE 301, READER SERVICE CARD

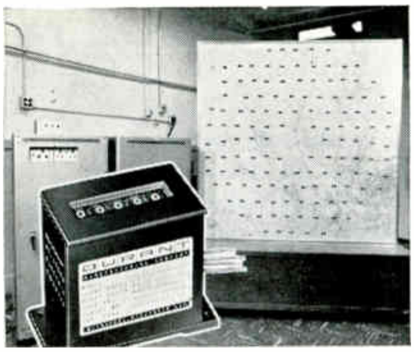
Electronic Gage Measures to 0.000001 Inch

MANUFACTURED by Brown and Sharpe Mfg. Co., 235 Promenade St., Providence 1, Rhode Island, are a series of transistorized electronic gages, the model 961 low magnification, model 962 high magnification and the model 964 differential. Range of low-magnification model is ±0.003, 0.001 and 0.003-in. with corresponding readout in increments of 0.0001, 0.000050 and 0.000010-inches. The high magnification is ±0.0003, 0.0001 and 0.00003-in. with corresponding readout in increments of 0.000010, 0.000005 and 0.000001-inch. Zero position on each amplifier remains unchanged with range switching. The differential amplifier has a continuously-variable range adjustment between ±0.003 and 0.0003-in. with readings from 0.0001 to 0.000010 inch. This unit may be used for absolute or comparative measurements with a single gage head or for reading sum or difference measurements by two gage heads. As shown in the sketch, the gage head consists of two coils with a sintered iron core centered between them. The core is attached to the gage spindle and moves axially. Its position relative to the coils affects coil impedance. The coils and transformer form a bridge and when the core rests equally between the coils the bridge is balanced and output signal is zero. When core is displaced, coil impedance is changed. A signal proportional to amount of displacement is generated, amplified, rectified and displayed on a d-c meter. **(302)**



Analog Computer Has Wide Dynamic Range

ANNOUNCED by Computer Systems, Inc., Industrial Park, Ft. Washington, Pennsylvania, the Dystac SS-100 solid-state analog computer has a computing range of +100 v to −100 v and features extreme precision at computing speeds from real time to iterative rates in excess of 1,000 solutions per second, modular construction, adaptable to linkage with digital computers in hybrid installations, and compatability with current precision analog



Precipitation Integrator Reveals "Nature's Secrets"

DURANT COUNTERS furnish instant, radar-calculated rainfall measurement from a widespread area to feed a computer in the preparation of river and flood forecasts.

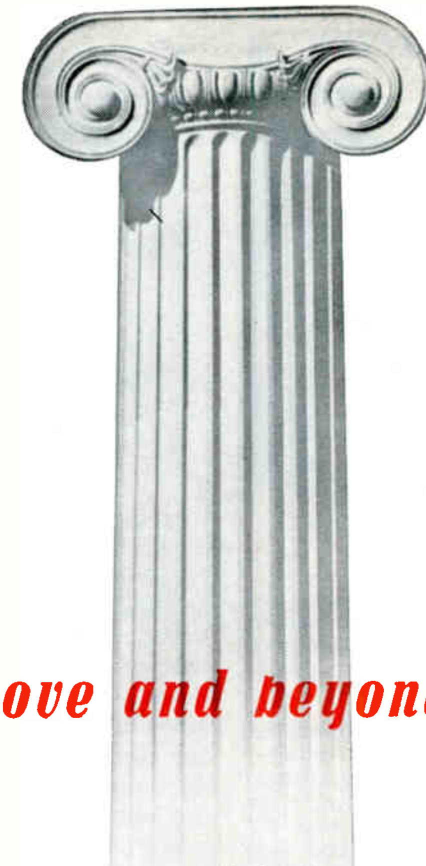
This new system was developed by Stanford Research Institute for the Weather Bureau, U. S. Dept. of Commerce, currently on test in Oklahoma. Existing radar installations are read electronically and this information is transmitted to the River Forecast Center. Precipitation is registered cumulatively in tenths of inches by Model "YE" Durant Electric Counters set in a display map of a river basin (basin illustrated has 150 counters). Counters are instantly reset electrically.

Durant "YE" Counters are ideal where important numerical data from many distant points is desired at a strategic control center . . . for visual observation or to be fed into a computer.

Timeter Translates Time Into Dollars

DURANT MANUFACTURING CO., Milwaukee, provides the counter for accurate records of chargeable production time. Money figures (cost or selling), or total work time, is read directly from Durant 4-Y-9434-T Counter. Total production time of worker, machine, operation or function is also recorded. To operate, the employee flips the switch at the start and, when finished, the reading is noted on the job record. If necessary to leave, the Timeter is turned off until employee restarts it.

Durant's easy-to-read figures, compactness and positive electric actuation provide dependable numerical data in applications where four figures are sufficient.



above and beyond...

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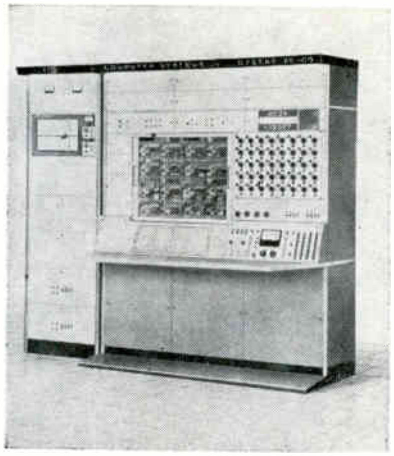
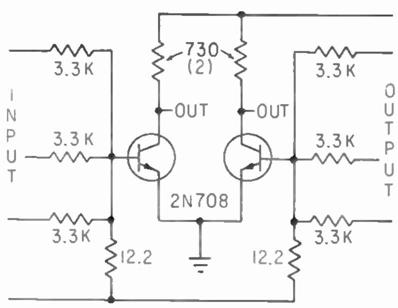


computing equipment. The 100-v level makes possible a dynamic range of 10,000 to 1 with computing accuracies of 0.01 percent at the lower range of the time scale. Although high packing density reduces parasitic capacitances and allows high computing frequencies, the highest range of computing frequencies requires operation at very-low impedance and voltage levels.

CIRCLE 303, READER SERVICE CARD

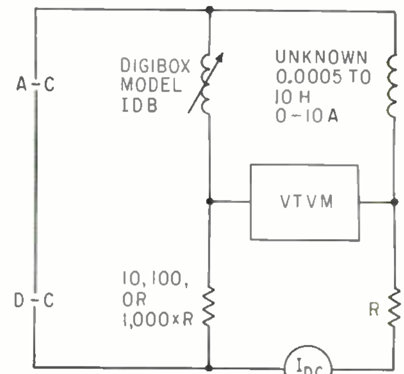


Double NOR Gate for Dense Packaging

INTRODUCED by Intellux, Inc., 30 S. Salsipuedes, Santa Barbara, California, the types GG700 and GG1050 double NOR gates are a combination of thin-film techniques and semiconductor devices. Supply voltage is 7 v and dissipation is 30 mw at 6 v for the GG700 and 10.5 v and 60 mw at 9 v for the GG1050. Pulse repetition rate is 1 Mc, propagation delay is 70 ns per stage, fan in is 3 and fan out up to 6. Each microcircuit is 3/8 × 3/8 × 1/2 inch, weighs less than 2 grams and is terminated with 13 pins suitable for insertion and dip soldering into a multilayer board. The sketch shows internal circuit of the GG700 double NOR gate. Semiconductors are nested in molded preform to provide additional heat sink. (304)

Determining Inductance Variation with D-C Current

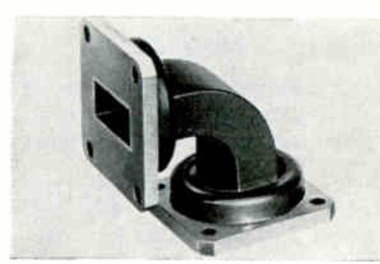
INTRODUCED by Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, California, the Digibox decade inductor enables simplified means of determining in-



ductance variation with d-c current. The sketch shows how any inductance between 0.0005 and 10 H can be determined. This sketch shows a choke, with d-c superimposed and requires only a vtvm, a 25-w a-c amplifier, a low-ripple 1 to 10 ampere d-c supply and the Digibox unit. (305)

Metal Stampings

BRAUN TOOL AND INSTRUMENT CO., INC., Hawthorne, N. J. Custom and standard beryllium copper precision metal stampings include component clips, contact strips and rings, printed circuit contacts, tube socket clips, diode clips, tube shields, crystal holders, etc. (306)



H and E-Plane Bends For X-Band

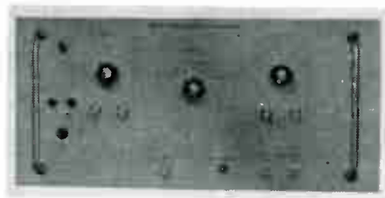
FXR DIV., Amphenol-Borg Electronics Corp., 33 E. Franklin St., Danbury, Conn., has developed a standard line of 90 deg H and E-plane bends at X-band for production runs of commercial and military

systems. Units are offered in a choice of both brass and aluminum, and ½ in. and 2½ in. radii. Max vswr is 1.05 over the frequency range of 8.2-12.4 Gc. All units are painted light grey in accordance with MIL-E-15090, Type II. Class II. Aluminum bends are chemically treated per MIL-5541 before painting.

CIRCLE 307, READER SERVICE CARD

All-Crimp Connectors Meet MIL-C-26482 C

BURNDY CORP., Norwalk, Conn., has developed a line of Smooth Bantam all crimp connectors which conform to MIL-C-26482C (Navy). Company supplies not only connector and contacts, but also provides crimping tools, both hand and automatic as a complete package. Other advantages: insert design which supports contacts to assure pin alignment and proper mating of plug and receptacle; closed entry socket with completely enclosed internal spring to prevent tearing or damaging of resilient insert or grommet. (308)



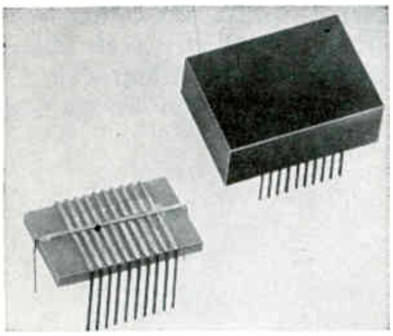
Modulator-Demodulator For Measurement Uses

WAYNE KERR CORP., 1633 Race St., Philadelphia 3, Pa. The SA 400 broadens use of the SA 100 transfer function computer. Unit is applied to carrier systems of between 50 and 2400 cps. (309)

Transistor Testers Offered in Two Types

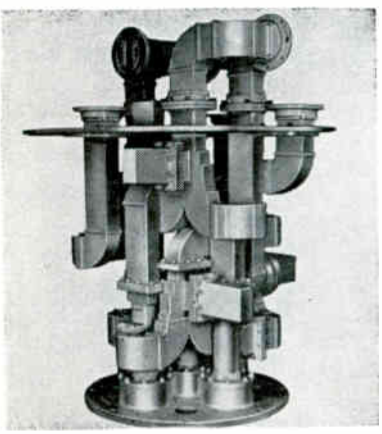
BAIRD-ATOMIC, INC., 33 University Road, Cambridge 38, Mass. Model

OT-1 high-frequency transistor test set measures gain (h_{fe}) at 20, 100, and 200 Mc by means of individual plug-in units. Measurement range is 1-10. Collector voltage is 0-30, and emitter current 0-100 ma. Accuracy is ±3 percent. Model PB-1 automatic transistor test set measures breakdown voltages and leakage currents up to 300 v. It also measures gain and saturation voltages up to 30 v and 500 ma. (310)



Micro Package Has Ten Transistors

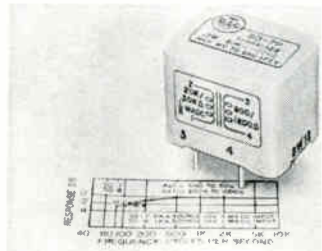
BURROUGHS CORP., P.O. Box 1226, Plainfield, N. J. Multi-element micro package consists of a strip of 10 *npn* diffused silicon transistors simultaneously fabricated and connected in a common emitter configuration. The transistors have high collector-emitter breakdown voltage which make them ideal for operation of gas discharge devices such as Nixie indicator tubes from low level signals. Current gains are typically 15. (311)



Signal Comparator For C-Band

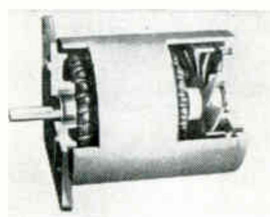
GOMBOS MICROWAVE INC., Clifton, N.J. C-band signal comparator is the feed system which forms an integral component of a high-power monopulse radar system. It provides the proper phases and amplitude characteristics for the transmitted and received signals, so that optimum tracking accuracy in both elevation and azimuth planes is achieved. Comparator is housed in a tapered cylinder closed at each end by a plate, and occupying about four cu ft. During target tracking by the radar system, the received pulse energy from the target enters the comparator channels at the circular ports joined to the antenna feed horns.

CIRCLE 312, READER SERVICE CARD



Audio Transformers Are Vacuum Molded

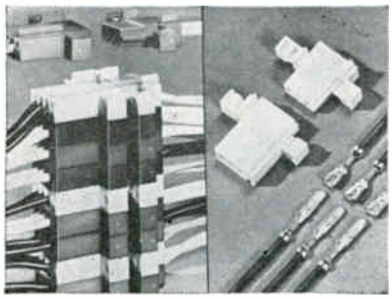
UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N.Y. Miniature audio transformers are vacuum molded to MIL Grade 5, Class R, Life X specifications. They employ 40 mil deeply anchored pin terminals ideally suited for p-c designs. Terminals are strong enough to support the light weight (approximately 0.4 oz) units. Physical design employs moisture barrier offset construction. Power levels range from 5 to 250 mw. Impedances range from 200,000 to 3.2 ohms. **(313)**



Fractional H-P Motors Come in 25 Models

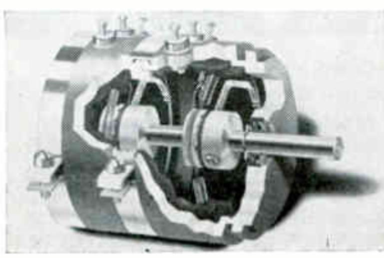
MCLEAN SYNTORQUE CORP., West Hurley, N. Y., offers a line of fractional h-p motors guaranteed for 20,000 hours of continuous duty.

Twenty-five models are available with 1/50 h-p to ½ h-p ratings in induction or hysteresis synchronous types, 60 cycle a-c. They operate from −30 C to 60 C. Ball bearings are cartridge type with long-life Mil-Spec lubricants. Rotors are dynamically balanced to 40 microinch excursions or better. Windings are class F high temperature polyester wound and impregnated. (314)



Modular Connector Has Color Coded Housing

AMP INC., Harrisburg, Pa., offers the 187 Fastin-Faston modular connector. A self interlocking housing device permits addition of modules without use of locking hardware. The 105C Nylon housing is color coded in a variety of nine colors and white and has a three rib design located over the number one contact for positive orientation and identification. Egg crate construction completely shields contacts and meets UL requirements in construction and material. Modular connector can be built in any combination of three circuits. Connector can be used with standard tabs and takes a wire size 20-16 Awg. Current capacity is 15 amp. (315)



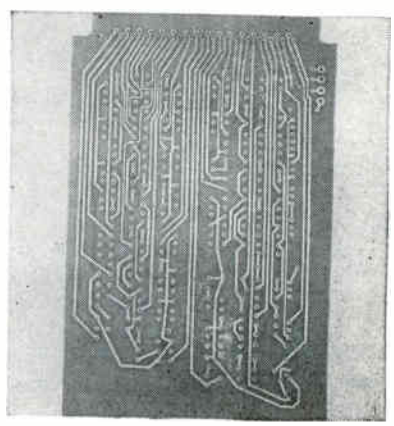
Wirewound Pots Are Single-Turn Devices

DALE ELECTRONICS, INC., P. O. Box 488, Columbus, Neb. Line of precision pots will be supplied in eight physical sizes from ⅞ in. to 3 in. in diameter. All sizes meet requirements of MIL-R-12934B and NAS-710. Single or ganged units will be available and special mechanical configurations, electrical angles and functions will be supplied to specification.

CIRCLE 316, READER SERVICE CARD

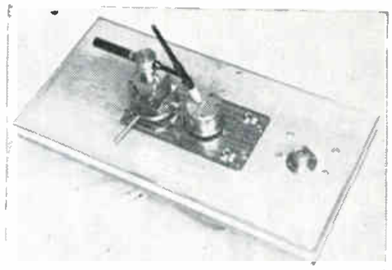
SCR Test Set Uses Pulse Techniques

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar Grove, N. J. Model SCR100 measures forward breakover voltage, peak reverse voltage, forward voltage drop, gate voltage and current characteristics, and other parameters. Forward voltage drop may be measured for currents from 1 ma up to 100 amp without use of external heat sinks. Breakdown voltage range is 0 to 1,000 v. All parameters can be measured either on the direct reading meter scales or via oscilloscope connections which are provided. **(317)**



Printed Circuits Meet MIL-P-55110

PHOTOCIRCUITS CORP., Glen Cove, N. Y. "Standard Circuits", a new type of printed circuit, reduce the cost of printed wiring boards by 40-60 percent, cut delivery time in half and eliminate most of the red tape and paperwork involved in the purchase of printed circuits. They meet the requirements of all military specifications relating to p-c boards and the acceptance criteria of MIL-P-55110. (318)



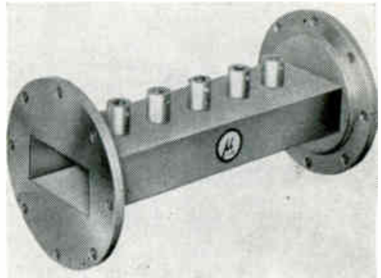
Welding Fixture Tracks Symmetrical Shapes

VAN ALLEN-ANDREWS, INC., 31 Holland Ave., Bridgeport 5, Conn. Model SF200 is a versatile welding fixture for moving a symmetrically shaped assembly in a precise path under an arc welding torch. It is ideal for welding hermetically sealed switches, relays, or any enclosed unit where flux removal is difficult. Operator merely places an assembled unit in a nest, places the nest in a fixture, flips a switch, and the unit is automatically welded while the operator is loading a second nest. A typical 0.400 in. by 0.800 in. crystal can relay like the one shown in the picture can be welded in only 8 sec. (319)

Shielded Room Is Prefabricated

FILTRON CO., INC., 131-15 Fowler Ave., Flushing 55, N. Y. New prefab shielded room features a fastening device which completely eliminates piercing the shield of the room. In addition, a new type of corner construction positively prevents any chance of r-f leakage. Filtron has also standardized its single door construction with a 36 in. width (clear opening) flush mounted. Erection and testing of the finished enclosures are made by Filtron's rfi specialists and are guaranteed to meet or exceed MIL-E-4957A and MIL-STD-285 requirements.

CIRCLE 320, READER SERVICE CARD

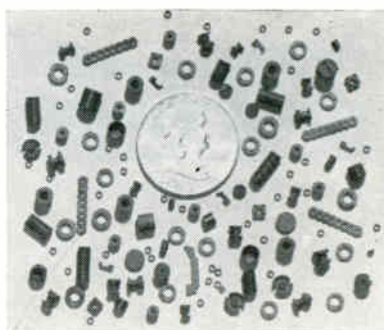


Waveguide Filters in Six Frequency Bands

MICROLAB, 570 West Mt. Pleasant Ave., Livingston, N. J. The VA and VB series narrow band preselectors cover the frequency range from 4 to 12 Gc in six bands. The filters utilize iris coupled TE_{101} mode resonators, and provide an optimum response shape over a wide tuning range. Minimum bandwidth at 3 db is 20 Mc. Max bandwidth at 30 db is 200 Mc for two section type, 115 Mc for the three section type, and 85 Mc for the four section type. Max vswr is 1.5 for all types. Peak power rating is 10 Kw. (321)

Coils

WABASH MAGNETICS, INC., First & Webster Streets, Wabash, Ind., has available a line of epoxy molded coils for all temperature ranges (Class A to Class H), and miniature ultra-fine wire coils. (322)



Ferrite Parts Are Microminiaturized

INDIANA GENERAL CORP., Electronics Division, Keasbey, N.J., introduces a broad line of microminiature ferrite parts such as toroids with an o-d of 0.018 in.; cup cores with an o-d of 0.230 in.; bobbins and sleeves of 0.118 in. in length; and other parts as thin as 0.005 in. Applications range from i-f transformers, as used in the micromodule program, r-f and pulse transformers, delay lines, recording heads, to miniature inductors for filter applications. (323)

High Power Loads

DE MORNAY-BONARDI CORP., 780 S. Arroyo Parkway, Pasadena, Calif. Two series of high power loads (air cooled and water cooled) feature high temperature, high heat conductivity, good thermal shock and virtually no cycling effects. (324)

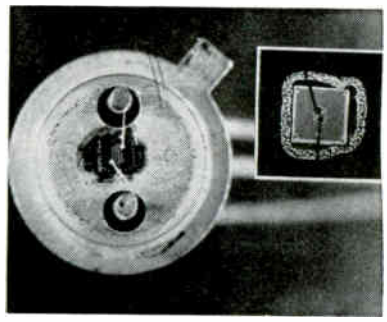
Relays

BRANSON CORP., Whippany, N. J., announces a complete line of time delay relays, transistor size relays, crystal can and ½ crystal can relays, two- and four-pole, plus a line of sockets designed specifically for relays. (325)

Pulse Modulator for High Output Radar

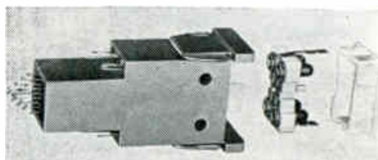
CALVERT ELECTRONICS, INC., 220 E. 23rd St., New York 10, N. Y., announces the English Electric C1148 radial beam pulse tetrode for use as the modulator in radar equipments having peak power outputs in the range 10 to 25 Kw. Although the heater consumption is only 31 w, peak output powers of 150 Kw are attainable. Tube has a short grid base, thus permitting relatively low grid drive requirements to provide full output power. Vacuum envelope is entirely of glass, incorporating a standard B5F base, and natural free air circulation gives adequate cooling in most environments.

CIRCLE 326, READER SERVICE CARD



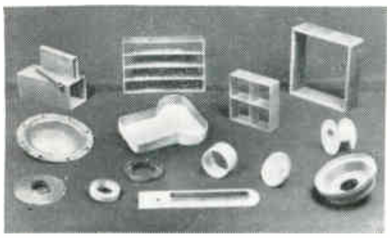
Planar Transistors For Industrial Use

SILICONIX INC., 1140 W. Evelyn Ave., Sunnyvale, Calif., announces two new P-channel planar diffused silicon UNIFETs (unipolar field-effect transistors) priced for industrial applications. The U-110 and U-112, in the TO-18 package, have two different geometries with a 1.1 to 1 ratio of g_m to I_{DSS} and 6 v max pinch-off on each device. 100 unit prices are $9.50 for the U-110 and $11.50 for the U-112. Storage temperature range is −65 to +200 C. Max gate-drain breakdown voltage is 20 v at $I_G = 1\ \mu a$. (327)



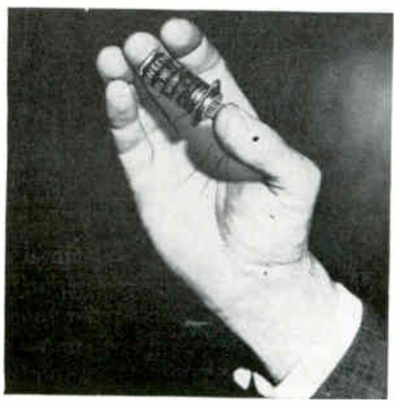
Display Switch Rated 1 Amp at 24 V

TELEX, INC., 3054 Excelsior Blvd., Minneapolis 16, Minn. Pushbutton display switch features high contact density per panel area. With an electrical rating of 1 amp at 24 v for over 500,000 operations, the wirebridge type switch is said to have no measurable contact bounce. Switch is well suited for dry circuit applications. Four-bulb indicator design provides greater reliability and multiple indication. It is constructed of heat resistant materials to provide for continuous four-bulb operation if desired. Switch is available in momentary or alternate (push-on, push-off) actions. A light operating force of only 20 oz is required for the 8-pole switch. (328)



Laminated Insulators In Variety of Sizes

STEVENS PRODUCTS INC., 86 Main St., East Orange, N. J., offers specially molded glass laminated insulation components. Glass silicone, epoxy, polyester, and melamine coil form tubes in over 800 standard sizes are available. Company has facilities for specially molded small motor insulation, slot wedges, end insulators, shaft collar, and acoustic diaphragms. (329)



D-C Amplifier Is Electrostatic Type

B.K. SWEENEY MFG. CO., 6300 E. 44th Ave., Denver 16, Colo. Miniature electrostatic d-c amplifier provides 10^{12} ohms input resistance and 5 pf capacity. Model SWE-1120A is simple, stable and requires only a zero adjustment. It is easily coupled into read-out devices of conventional impedance levels and is especially useful when signal loading must be kept at an absolute minimum. Amplifier drives an external output of 100,000 ohms minimum with a power gain of 50 db minimum. Frequency response is d-c to 100 Kc within 3 db. (330)

Literature of the Week

TRANSFORMER-RECTIFIERS Tung-Sol Electric, Inc., One Summer Ave., Newark 4, N. J. Short form catalog lists specifications on 22 different models of transformer-rectifiers for airborne power conversion.
CIRCLE 331, READER SERVICE CARD

AEROSPACE INSTRUMENTATION Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif., has published an illustrated brochure describing its capabilities in the field of aerospace instrumentation. (332)

FACILITIES BROCHURE Litton Industries, Electron Tube Division, 960 Industrial Road, San Carlos, Calif. A 36-page illustrated 1963 summary of products and review of capabilities is available. (333)

COMPUTER TIME CLOCKS Electronic Engineering Co. of California, Box 58, Santa Ana, Calif. Data sheet describes the EECO 790 and 791 Datachron time clocks for computers and data processing systems. (334)

POTENTIOMETERS Spectrol Electronics Corp., 1704 South DelMar Ave., San Gabriel, Calif. A 10-page short form catalog describes a line of precision potentiometers, turns-counting dials and trimming potentiometers. (335)

ELECTRONIC HARDWARE Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif., offers the 1963 edition of a 32-page catalog on the Lerco line of electronic hardware. (336)

RANDOM-NOISE GENERATOR General Microwave Corp., 155 Marine St., Farmingdale, L. I., N. Y. Model 503 broadband random-noise generator is illustrated and described in a catalog sheet. (337)

LEVEL MEASUREMENT Magnetic Instruments Co., Inc., Thornwood, N. Y. Data bulletin 6.0 discusses level measurement and control applications utilizing capacitance-type level device. (338)

ELECTRONIC CHOPPER Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif. Single-sheet bulletin describes the model 70 silicon transistor electronic chopper with operating temperature from −55 C to +130 C. (339)

MAGNETOMETERS Varian Associates, 611 Hansen Way, Palo Alto, Calif. Data sheet illustrates and describes the V-4931 series marine/station magnetometers. (340)

SILICON EPITAXIAL MESA TRANSISTORS Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. Brochure outlines types TO-5 and TO-46 *npn* large signal silicon epitaxial mesa transistors. (341)

RESISTORS Electra Mfg. Co., Independence, Kansas, has available two new catalogs outlining its complete lines of precision carbon film and metal film resistors. (342)

WROUGHT ALLOYS Special Metals, Inc., New Hartford, N. Y., offers a wall chart featuring 16 micrographs of two vacuum induction melted super-alloys — Udimet 700 and Udimet N-115. (343)

TAPES, GASKETS & COILS Garlock Inc., Palmyra, N. Y., has released a bulletin describing five styles of gasketing tapes, seven styles of folded asbestos gaskets and eight styles of gasketing coil. (344)

MONOPULSE TRACKING RECEIVER Defense Electronics, Inc., 5455 Randolph Rd., Rockville, Md. Bulletin covers the TTR-2, a complete sum and difference monopulse tracking receiver. (345)

MASS FLOWMETER Technology Inc., 3090 Richfield Center, Dayton 30, O. Linear gas mass flowmeter, MFM-150-1, is described in a recent bulletin. (346)

CIRCULAR WAVEGUIDE Andrew Corp., P.O. Box 807, Chicago 42, Ill. Bulletin 8495 covers the WC530D circular waveguide that features low attenuation. (347)

STANDARDIZED BATTERY HOLDERS Keystone Electronics Corp., 49 Bleecker St., New York 12, N. Y., has released an 8-page catalog of battery holders and battery holder accessories. (348)

COAXIAL CABLE ASSEMBLIES Paraplegics Mfg. Co., Inc., 304 North York Road, Bensenville, Ill. Catalog announces a complete line of coaxial cable assemblies for every requirement. (349)

PULSE GENERATORS Intercontinental Instruments Inc., 123 Gazza Blvd., Farmingdale, L. I., N. Y. A six-page brochure on the TPG series of pulse generators provides data on both single pulse and double or delayed pulse instruments. (350)

MEASURING RECEIVER Rohde & Schwarz, 111 Lexington Ave., Passaic, N. J. The Selektomat measuring receiver with an electronically-tuned local oscillator is described in a technical information bulletin. (351)

CUSTOM CABLE CONSTRUCTIONS Chester Cable Corp., Chester, N. Y. A 12-page folder shows how custom cable constructions are designed and manufactured. (352)

SILICON PLANAR TRANSISTORS Sperry Semiconductor, Division of Sperry Rand Corp., Norwalk, Conn. A 32-page illustrated brochure presents a compilation of information gathered from seminars on complementary silicon planar transistors. Request copy on company letterhead.

CLOSED-CIRCUIT TELEVISION Cohu Electronics, Inc., Kin Tel Division, Box 623, San Diego 12, Calif. Data sheet 8-40 lists more than 75 examples of applications for closed-circuit television. (353)

Babcock Sets Up Florida Division

BABCOCK ELECTRONICS Corp. recently dedicated a new 20,000-square foot plant in Orlando, Fla. Cost of the entire complex is in excess of $300,000.

The Orlando division is the first major out-of-state facility of Babcock Electronics, Costa Mesa, Calif. It will manufacture electromechanical systems for use in such areas as guidance, communications, countermeasures, sub-systems and special support equipment. Two other divisions, the Aero Space division and the Relays division, are located in plants in Costa Mesa.

The Florida manufacturing complex was the result of a major expansion program undertaken by the California company early last year. Reasons for locating in Florida include the nearness of Cape Canaveral and the Atlantic Missile Range, and the proximity of other prime missile contractors, to whom it could offer sub-contracting.

The Orlando division will not engage in any R&D programs—only the assembly and manufacture of these systems. Company says as many as 100 persons may be employed there within the next six months. Of the total plant area 15,000 square feet will be used for production. The remaining space will house administrative offices. The building, on a 20 acre site, is designed on the modular concept, thus allowing future expansion to total more than 200,000 square feet.

Babcock Electronics Corp. was formed in 1948. It does business with the military, either direct or through other prime contractors, as well as various industrial concerns. The Aero Space division develops and produces advanced systems for the command control and guidance of ballistic missiles, high speed targets, remote controlled anti-submarine helicopters and vehicles used in nuclear experiments. The Relay division makes subminiature precision relays for aircraft, missiles and industrial applications.

General manager of the Orlando division is Fred A. Cullman. Other executives include Carroll S. Miller, management consultant; Guy L. Cole, engineering manager; Charles J. Filko, manager of production; Robert McClintock, Jr., quality assurance manager; and R. A. Zimorski, material manager.

Sanders Associates Appoints Peyser

SANDERS ASSOCIATES, INC., Nashua, N.H., has announced the appointment of William P. Peyser to the position of general manager for the company's Microwave division. He will have overall responsibility for the division's engineering, manufacturing and marketing efforts.

Prior to joining Sanders, Peyser was section head and project director at Airborne Instruments Laboratory, Aerospace Systems department.

Honeywell EDP Opens Another Building

HONEYWELL Electronic Data Processing recently opened its third administration building in as many years at its Wellesley Hills, Mass., headquarters. This brings to eight the number of engineering, research, manufacturing and administrative facilities maintained by the firm in the Greater Boston area.

The company, manufacturer of high-speed digital computers, has more than 3,000 employees in plants at Brighton, Lowell, Needham, Newton and Wellesley Hills.

The new 32,000-sq ft facility will house the programming systems division.

Sperry Rand Univac Elevates Horrell

APPOINTMENT of Maurice W. Horrell as vice president-engineering and manufacturing for the Univac division, Sperry Rand Corp., is announced.

Horrell, who joined Univac as director of engineering and manufacturing in 1962, is responsible for all divisional engineering and manufacturing programs. Univac manufacturing facilities are located in Philadelphia; St. Paul; Dallas; Ilion-Utica, N.Y.; Genoa, Ill.; and

DYNAPLEX CORPORATION

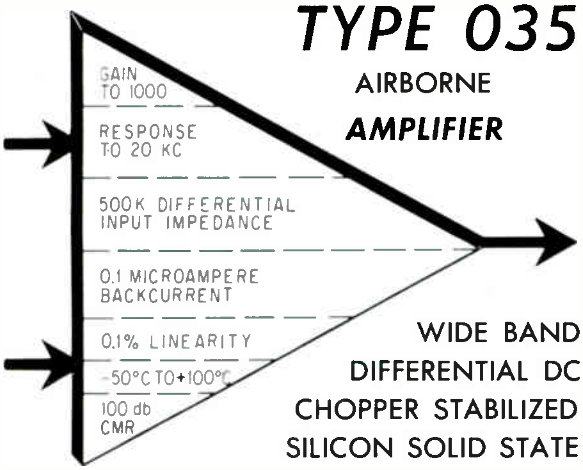
— *INTRODUCES* —

ITS NEW HIGH PERFORMANCE

TYPE 035

AIRBORNE

AMPLIFIER



WIDE BAND
DIFFERENTIAL DC
CHOPPER STABILIZED
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DESIGNERS AND MANUFACTURERS OF

- SOLID STATE MULTIPLEXING SWITCHES
- PAM, PDM, PPM MULTICODING SYSTEMS
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- SIGNAL CONDITIONING EQUIPMENT

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CIRCLE 204 ON READER SERVICE CARD

New TWO-WAY Counter*

- ☐ **AC line for lab operations**
- ☐ **Battery-powered for field use**

$875.00

*available to 2.5 mc

Here is the newest solid state Counter-Timer available . . . Accurate Instrument's Model 5A35 . . . 5½" wide and only 17 lbs., including batteries! This bright, easy-to-read counter has internal, rechargeable batteries for field work on shipboard, flightlines, etc.—a truly portable counter. The unit is AC powered for accurate lab use. Remotely programmable, the Accurate Counter offers these measurement functions: frequency (.1, 1 and 10 second time base), period (X1, X10, X100 and X1000) and ratio. Compact for inclusion in systems work, too.

SPECIFICATIONS: Frequency and Period Measurement: DC to 300KC ■ Display: five 10-digit, brightly illuminated columns ■ Input Sensitivity: 0.1 volt ■ Input Power: 115 volts at 15 watts, 50 to 70 cps or 8 internal size D nickle cadmium batteries ■ Size: 7" H x 5½" W x 12¼" L ■ Remotely programmable ■ No Operating Adjustments.

Write for Catalog Information

ACCURATE INSTRUMENT CO.
Phone JA 6-4946 (713) P. O. Box 66373
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CIRCLE 205 ON READER SERVICE CARD

What Can You Do With a SirKit* WAFER?

ACTUAL SIZE

**The First Successfully Mass Produced Micro-Miniature Integrated Circuits.*

Looking for an integrated, thin film micro-miniature circuit that meets your specific requirement? Just name your application . . . DIGITAL LOGIC CIRCUITRY . . . LINEAR AMPLIFIERS . . . ANALOG PROJECTS . . . MATCHED NETWORKS . . . RC NETWORKS . . . IF STRIPS. Hand us your specifications and National does the rest . . . on a SirKit wafer. Quantities? You name them too . . . we can deliver up to 12,000 per day.

"Utterly Fantastic!" you say? True, but there's no magic involved here . . . just the use of National's patented thin film techniques for producing passive componentry . . . combine with proven semi-conductor devices . . . add strict standardization of formulation, atmospherics and time. The result . . . reliable, lottery-free integrated circuits. National's exclusive design, tooling and processing assures quantity deliveries of SirKit wafers within five weeks from receipt of an order . . . savings in cost are worthy of note too.

Send today for the **Utterly Fantastic** story of SirKit wafers, supported by Applications Sheets and Test Data Results.

Don't forget to attend the symposium on Integrated Circuits at the SirKit Suite, Plaza Hotel, during the IEEE (IRE) Show . . . Send for free reservation on company letterhead.

***National ResisTronics** INC.*
56 WALTER STREET, PEARL RIVER, NEW YORK

CIRCLE 115 ON READER SERVICE CARD

Holyoke, Mass. The company maintains engineering centers at Whitpain Township, Pa.; Dallas, Texas; and St. Paul, Minn.

Electron Heating Appoints Ingalls

W. BRADFORD INGALLS, formerly with Alloyd Electronics Corp., has been appointed executive vice president at Electron Heating Corp., Medford, Mass. In this position, he will be responsible for the direction, planning and execution of the overall company operation.

Electron Heating Corp. is an affiliate of the General Vacuum Corp., manufacturer of vacuum systems.

Littelfuse Names H. A. Cornelius

HERBERT A. CORNELIUS has been appointed to the newly created position of vice president in charge of manufacturing at Littelfuse, Inc., Des Plaines, Ill. He was formerly vice president in charge of manufacturing sales.

Littelfuse produces circuit protection and control devices.

Hancock Telecontrol Sets Up New Division

HANCOCK TELECONTROL CORP., New York City, has announced the establishment of its Datametric division which will specialize in the development, manufacture, and marketing of instruments and other devices for use in the control of industrial operations by management.

The new division will be under the direction of George V. Mohn, vice president, marketing. Datametric products will be engineered

and manufactured at the company's plant in Old Greenwich, Conn. Additional personnel are being hired for the purpose.

Babits Assumes New Post

VICTOR A. BABITS has advanced from chief to manager of research at General Dynamics/Astronautics in San Diego, Calif. He assumes overall responsibility for the Applied Research Laboratories' scientific program, including laser and opto-electronic research.

Before joining GD/Astronautics, Babits was professor of electrical engineering at Rensselaer Polytechnic Institute.

Schneider Joins Electra Manufacturing

JACK B. SCHNEIDER has been appointed to the new post of vice president of operations at Electra Mfg. Co., Independence, Kansas. Electra manufactures resistors, capacitors, micromodules, and integrated circuits.

Schneider was previously division manager of the Bay City, Michigan, division of Electric Autolite Co.

Announce Formation of New Company

SIX former Varian Associates employees have left the firm to form their own company, Mitek Corp., Menlo Park, Calif. The new firm's president is Maurice W. St. Clair, former director of Melabs, Inc., also of Menlo Park.

Mitek will specialize in stable frequency sources and parametric devices, with their initial efforts including development and manufacture of high-Q cavities for stabilizing reflex klystrons, filter applications and harmonic generators.

Arnold Magnetics Appoints Quinn

THOMAS B. QUINN has been named general manager of Arnold Magnetics Corp., Los Angeles, Calif. He will report directly to Forrest M. Arnold, company president.

Quinn joined the firm as operations manager in late 1961.

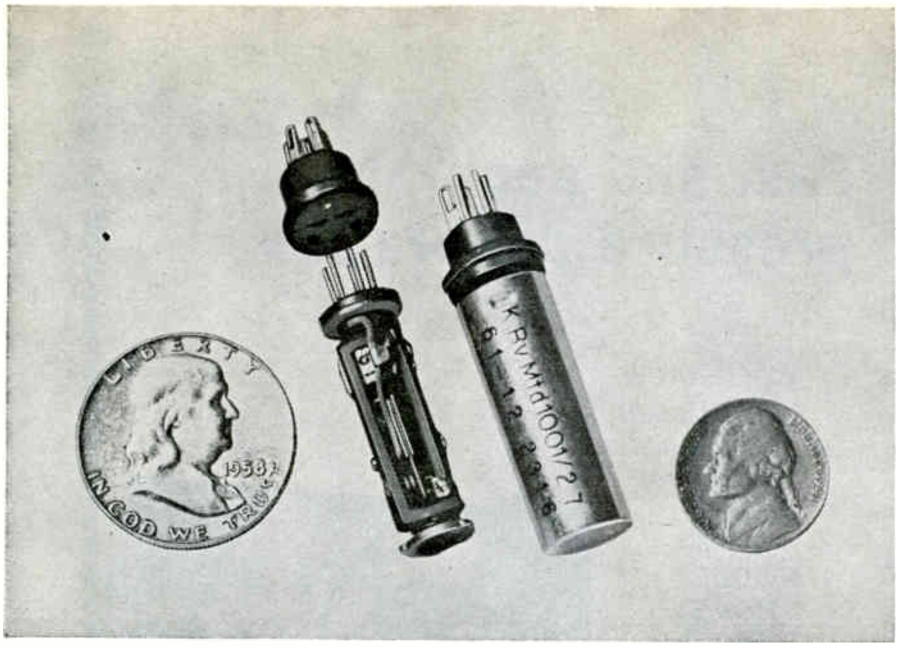
Reeves Soundcraft Names Kane

JOHN S. KANE has been named vice president of Reeves Soundcraft Corp., New York City. He will be general manager of Soundcraft's magnetic tape division in Danbury, Conn.

Prior to joining Reeves Soundcraft, Kane was assistant director of operations for International Resistance Co. of Philadelphia.

Marble Moves Up at Systron-Donner

FRANK G. MARBLE has been appointed a vice president of Systron-Donner Corp., Concord, Calif. Marble, who has served the company as



assistant to the president and marketing manager, has held senior management positions with Boonton Radio Corp., Philco Corp. and Kay Electric Co.

Systron-Donner is engaged in the development and manufacture of transducers, flight control devices, test and measuring instruments, analog computers and accelerometers.

PEOPLE IN BRIEF

Gottfried R. Rosendahl leaves GE to join ITT Federal as senior scientist. **Bernard Friedland,** formerly with Melpar, Inc., appointed principal staff scientist in control at General Precision's Aerospace Research Center. **Jerome L. Herold,** ex-Fairbanks, Morse & Co., named director of materiel and procurement for the Space Systems div. of the Martin Co. **Howard Courter,** previously with Riddle Airlines, Inc., joins Aerospace Electronics, Inc., as mgr. of quality control. **Fred T. Sinnott,** from GD/Astronautics to Kinetics Corp. as chief electronics engineer. **Frank Waldhorst,** recently with Transnuclear Corp. and Pitometer Log Corp., now production mgr. at M. Ten Bosch, Inc. **John Spanos** promoted to asst. director of mfg. at the Semiconductor div. of Hoffman Electronics Corp. **Daniel Shevelenko** leaves Cook Electric Co. to become director of engineering at Hathaway Instruments, Inc. **George A. Bronson** moves up to director, engineering & operations, of General Technology Corp. **George W. Pratt** advances to mgr., overseas operations for Philco's Lansdale div. **George Merker,** ex-ElecTroTec, now managing director of newly formed Gyrex, Inc. **Edward D. Sherman,** formerly with California Technical Industries, appointed plant production mgr. at Eldorado Electronics. **James W. Otis** promoted to mgr. of mfg. operations for the Eagle Signal div. of E. W. Bliss Co. He succeeds **W. P. Juckem** who was named asst. to the president for the Bliss Co. Fairchild Defense Products ups **George M. Walsh** to inspection and test mgr. at its headquarters facility.

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 #
ACF INDUSTRIES INC Albuquerque Division Albuquerque, New Mexico	223*	1
AEROSPACE PLACEMENT CORP. Phila. 3, Penna.	222*	2
AFSC-AFLC Joint Professional Placement Office New York, N. Y.	221*	3
ATOMIC PERSONNEL INC. Philadelphia, Penna.	122	4
BELL AEROSYSTEMS CO. Div. of Bell Aerospace Corporation A Textron Company Buffalo, New York	223*	5
BENDIX CORPORATION Kansas City Division Kansas City, Missouri	220*	6
BOOZ, ALLEN APPLIED RESEARCH INC. Bethesda, Md.	222*	7
BRISTOL COMPANY Waterbury, Conn.	122	8
BROOKHAVEN NATIONAL LABORATORY Upton, New York	215*	9
ELECTRO INTERNATIONAL INC. Annapolis, Md.	122	10
GENERAL DYNAMICS, ELECTRIC BOAT Groton, Conn.	123	11
GENERAL DYNAMICS/ELECTRONICS Rochester 1, N. Y.	217*	12
HONEYWELL St. Petersburg, Fla.	118	13
NORDEN Div. of United Aircraft Corp. Norwalk, Conn.	219*	14
PAN AMERICAN WORLD AIRWAYS INC Guided Missiles Range Div. Patrick AFB Fla.	218*	15
PERSPECTIVE Needham Heights, Mass.	222*	16

(Continued on page 122)

(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) 32263

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

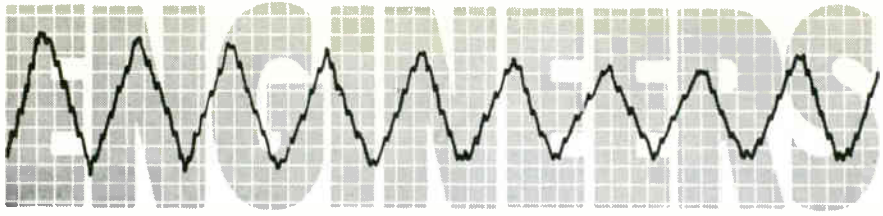
CATEGORY OF SPECIALIZATION

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



JOIN THE LEADER IN THE HIGHLY SPECIALIZED FIELD OF RADIO FREQUENCY INTERFERENCE

ELECTRO-INTERNATIONAL, is a medium sized growth company offering unusual benefits, PLUS unequalled professional and remunerative advancement in a healthy year-round community living environment for men with the following qualifications:

CIRCUIT DESIGN (All Levels)

B.S. E.E. or M.S. E.E. min 3 years experience with project and/or supervisory experience desired. Systems or equipment design, evaluation and test engineering experience essential, as applied to military & commercial hardware involving broad Radar & Communication techniques.

EQUIPMENT IMPROVEMENT

B.S. E.E. or M.S. E.E. with strong practical systems background. Ability to re-work, re-design, modify and improve hardware for both military and commercial application. Must be able to generate ideas towards concepts breakthrough.

New York Interviews *During IEEE convention Call Mr. C. Scott Lewis* **CO 5-2974**

If unable to apply, send resume

ELECTRO-INTERNATIONAL INC.
A subsidiary of Electro Instrument
Greenwood Acres, Annapolis, Md.
An Equal Opportunity Employer

TO ENGINEERS WHO ARE LOOKING FOR THE ROUTE TO THE TOP:

BRISTOL'S

Enter the sales field and benefit directly and rapidly from the effort you put forth. In sales engineering, you solve the industrial problems and make the recommendations for the technical equipment or services to produce the needed result; you gain the added benefit and satisfaction of applying your engineering and technical knowledge for the customer. Success in selling (and sales engineering is no exception) inevitably leads to greater responsibility for you, and to proportionately higher income. You are challenged to deevlop a stronger capability for getting along well with others, for exercising judgment, and for building the kind of background that is today most highly valued in business enterprises. These are the vital qualities which lead to the top! Sales engineering should interest you! Send us your resume. We design, develop, and manufacture instruments and control systems to be marketed nationally by our own sales team. *You can be an important part of that team.* Successful applicants are given a comprehensive three-months course at headquarters, with regular salary and expenses from start of employment. All replies will be held in complete confidence, and every inquiry will be answered.

Write: **Charles F. Johnson, Manager of Sales Training**

The Bristol Company Waterbury 20, Conn.

(An equal opportunity employer)

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 121)

SPACE TECHNOLOGY LABORATORIES INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	13*	17
SVERDRUP & PARCEL AND ASSOCIATES INC. St. Louis, Mo.	222*	18
TELEVISION ASSOCIATES OF INDIANA, INC. Michigan City, Indiana	222*	19
U. S. DEPT. OF COMMERCE National Bureau of Standards Boulder Labs. Boulder, Colorado	222*	20
VEZAN—WEST & COMPANY W. Hartford 7, Conn.	222*	21

* These advertisements appeared in the March 15th issue.

E. E.'s

for FEE-PAID Positions WRITE US FIRST!

Use our confidential application for professional, individualized service . . . a complete national technical employment agency.

ATOMIC PERSONNEL, INC.
Suite 1207L, 1518 Walnut St., Phila. 2, Pa.

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 7/8" 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.

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

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

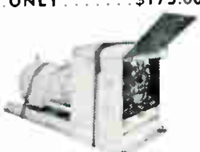
SAVE! BIG MONEY on GENERATOR SETS

MOTOR-GENERATOR, AC TO DC

Motor: 5 H.P. 3510 RPM, 220/440 volts. 60 cycles, 3 phase. Type OGX, Frame 225, Class G, Form B. Generator: 28 volts, 100 amperes D.C. Model No. 60. Made by Motoresearch Co. Equipped with motor starter box and generator control panel. Complete assembly mounted in tubular frame for portability. Shpg. wt. 250 lbs. F.O.B. Chicago

No. AS-G764 .... ONLY $175.00

50 KW, 400 CYCLE MOTOR GENERATOR SET



Ideal Type F-1. Rated 62.5 KVA, 50 KW, 120/208 volts, 3 phase, 400 cycles, 0.8 P.F. Powered by 60 cycle, 3 phase, 220/440 volt motor. Complete with instrument and control panel. Overall dimensions: 85" L, 34" W, 41" H. Shpg. wt. 2100 lbs. F.O.B. Chicago.

No. AS-G964 ...... ONLY $1,250.00

FREE CATALOG!

Write today for Groban's NEW 72 page Equipment Catalog and Hydraulic Reference Manual. Tremendous Savings on hundreds of items.

GROBAN SUPPLY COMPANY, INC.

1139 So. Wabash Ave., Dept. AS-3, Chicago 5, Ill.
WEbster 9-3793 • Cable: GROBANCO — CHICAGO

CIRCLE 950 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS 3 & 10 CM. SCR. 584 AUTOTRACK RADARS. AN/TPS-10 SEARCH. AN/TPS-1D 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 951 ON READER SERVICE CARD

OVER 2,000,000

RELAYS

IN STOCK!

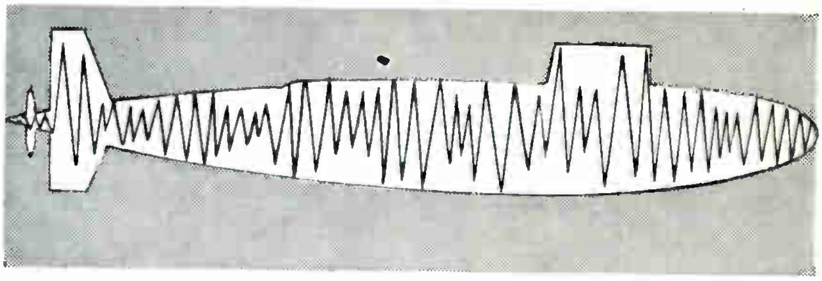
Send for Catalog SS

Universal RELAY CORP.

42 WHITE ST., N.Y.13, N.Y. • WAlker 5-6900

CIRCLE 952 ON READER SERVICE CARD

Look what EE's are doing



at ELECTRIC BOAT

- Design of Special Instrumentation for Measurement of Acoustic & Vibration Data
- Design & Installation of Interior Communication Systems, Navigation Systems, Ship Control Systems, Depth Control Systems, Steering & Diving Devices
- Application and Systems Engineering of Radio, Radar, Sonar & Countermeasures Systems & Components
- Design and Installation of Electric Power Plants & Distribution Systems
- Quality/Reliability Control & Assurance
- Nuclear Power Plant Systems Schematics Review
- Advanced Circuit Design
- Electronic Systems Engineering
- Missile Fire Control, Guidance and Checkout Systems & Equipment
- Installation and Test of Reactor Plant Auxiliary Power Supplies
- Integration of Control and Instrumentation Systems
- Navigation Systems and Equipment
- Procurement • Signal Systems Analysis
- Vendor Product Application Design
- Electrical Power & Control Systems & Component Design
- Test Development & Instrumentation Design
- Vendor Performance Analysis
- Process Control Engineering & Instrumentation
- Sound, Shock & Vibration Analysis

As a world of technology in miniature—incorporating missile launching systems, a nuclear propulsion plant, and life support systems—the nuclear submarine is an engineering challenge of the highest order. The Electrical and Electronic Engineer working at Electric Boat has a unique opportunity for professional development, not only in his own specialty but through broad knowledge gained in the unity of all technologies.

Your resumes are invited. Please address Mr. Peter Carpenter.

GD

GENERAL DYNAMICS ELECTRIC BOAT

Groton, Connecticut

AN EQUAL OPPORTUNITY EMPLOYER

INDEX TO ADVERTISERS

■

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.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but **electronics** assumes no responsibilities for errors or omissions.

electronics

Audit Bureau of Circulation

Associated Business Publications

Audited Paid Circulation

JAMES T. HAUPTLI
Advertising Sales Manager

BEN ANELLO
Market Services Manager

DAVID CUNNIFF
Promotion Manager

■

RICHARD J. TOMLINSON
Business Manager

■

Electronics Buyers' Guide

R. S. QUINT
General 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):
John 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):
Ashley P. Hartman, John G. Zisch,
William 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):
Richard 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

TOKYO:
George Olcott,
1, Kotohiracho, Shiba, Minato-ku

SPERRY PHASE-LOCKS BWO'S BY SIGNAL INJECTION

IN: **Microwatts from the most stable frequency source you can find**

OUT: **10-30 mW power at 48 to 86 Gc, and just as stable**

Local oscillator output frequency control by injection phase-locking, heretofore unavailable in the millimeter region, is now available with two new Sperry BWO's.

Sperry Electronic Tube Division is offering two new BWO's — the SBM-421, voltage tunable from 48 to 63 Gc, and the SBE-402, voltage tunable from 65 to 86 Gc.

Because of Sperry's precision design and manufacturing techniques, the addition of an optional input waveguide to these two tubes simplifies frequency stabilization of their outputs. The input waveguide is used to introduce a very low-power (as little as 1 microwatt) signal from an unusually stable frequency source. The 10 to 30 mW output of the BWO is then slaved to the frequency stability of the input source.

Use of this technique can greatly simplify the task of millimeter wave system designers who require precision frequency control. Injection phase-locking eliminates complicated electronic stabilization loops. This development is also expected to improve the accuracy of doppler radar systems and to open many new application possibilities in the millimeter region of the spectrum.

A FREE TECHNICAL BOOKLET gives full details on new Sperry BWO's and their optional injection phase-locking feature. For your copy, write to Sperry Electronic Tube Division, Sperry Rand Corporation, Gainesville, Florida.

Also described in the booklet are other system-simplifying features of the Sperry BWO's. These include permanent magnet focusing, a gridded triode gun, and photo-etched slow-wave structures.

For specific information or quotation, contact the appropriate Sperry Sales Representative: in the U.S.A., the nearest office of Cain & Co.; in Europe, Sperry Europe Continental, Paris.

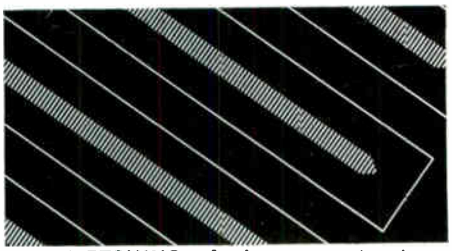


PHOTO-ETCHING of slow-wave structures from negatives like this (shown greatly enlarged) gives significantly superior performance to Sperry BWO's.

SPERRY ELECTRONIC TUBE DIVISION

SPERRY RAND CORPORATION
GAINESVILLE, FLA. / GREAT NECK, N. Y.