A McGraw-Hill Publication 75 Cents July 6, 1962

electronics

(Photo at right)

CIRCUIT IN NEEDLE'S EYE

differential amplifier on silicon block, p 37

INTERCEPT RECEIVER

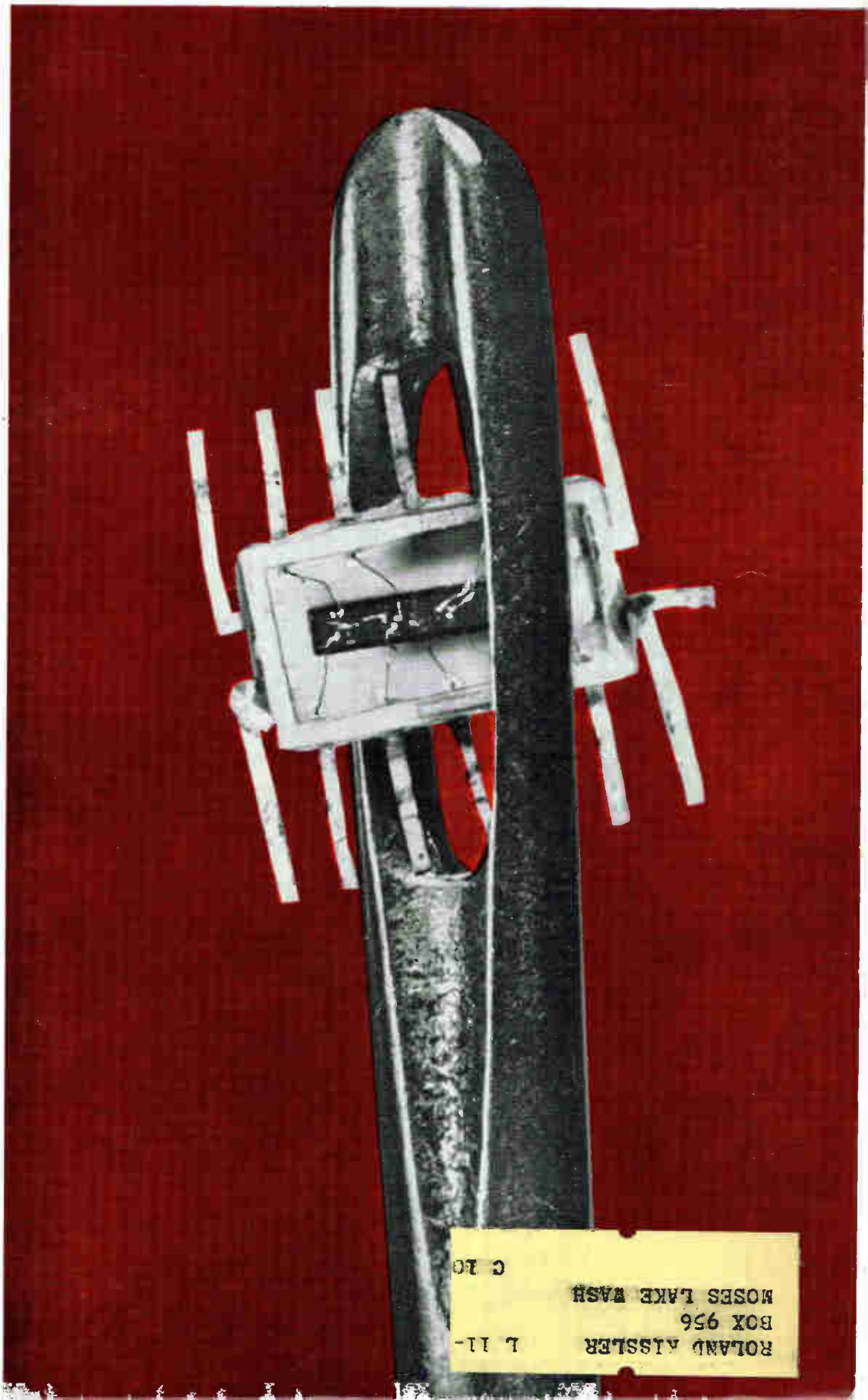
uses only passive tuning circuits, p 40

MAGNETIC PEGBOARD

generates digital test signals, p 46

IMPROVING AMPLIFIERS

new method optimizes gain-bandwidth, p 54



TYPICAL RAYTHEON O-TYPE BWO'S FOR LABORATORY INSTRUMENTS*

TYPE	FREQ., kMc	POWER
QKB 913	1.1 – 2.0	100 mW min.
QKB 914	2.0 – 4.0	70 mW min.
QKB 915	4.0 – 8.0	20 mW min.
QKB 916	8.0 – 12.4	20 mW min.
QKB 890	12.4 – 18.0	40–180 mW
QKB 891	18.0 – 26.5	40–180 mW

*Complete O-type BWO line includes 45 different tubes

Why 3 out of 5 BWO's in new microwave signal generators are Raytheon

Certainly it's more convenient to select from Raytheon's 45 different BWO's. But most needs are met with six tubes covering 1 to 26.5 kMc (above). They're unusually compact and incorporate grids for low-voltage pulse and amplitude modulation or the application of AGC. Write for more reasons in technical data. Raytheon Co. □ Microwave and Power Tube Div., Waltham 54, Mass.

CIRCLE 900 READERS SERVICE CARD

RAYTHEON

July 6, 1962

electronics

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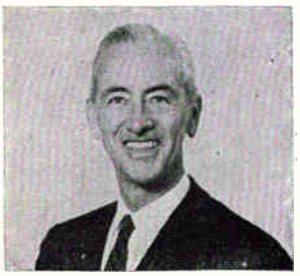

W. W. MacDONALD, Editor

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electronics

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DEPARTMENTS

Competition from Japan

IT IS APPARENT that Japanese and American electronics companies have become intimately connected just as U.S. and European electronics companies have become financially and technically intermixed. The companies that have entered into such agreements have done so because it has been profitable.

There seems to be little argument that the two-way flow of technical information across the Pacific raises the state of the art on both shores. Another type of partnership is the manufacturing agreement under which a Japanese firm makes American-developed products for sale in Asia and other overseas markets. Such arrangements have been sought by American companies that could not otherwise profitably compete against local producers with lower costs, or against trade restrictions.

The Japanese-American business activity that most disturbs the U.S. electronics industry is the importing of lower-priced components and consumer goods. This cuts into sales of some domestic products, especially transistors and transistor radios. Less publicity—chiefly because American firms play these cards close to their vest—has been given the purchase in Japan of parts of components (not the components themselves) and subassemblies for consumer products. These are assembled here and carry the tag "Made in USA."

Are these practices reprehensible? Should they be stopped or restricted? American companies that have been hurt think so, and say so. Less vocal are American companies that have turned to lower-cost Japanese products in their effort to remain competitive in world markets.

More than two years ago, the Electronic Industries Association petitioned the government for import quotas on Japanese transistors, on grounds that quotas would preserve our ability to produce sufficient transistors for defense. A few weeks ago, EIA finally got the answer: No. The Office of Emergency Planning said that despite the imports U.S. industry was expanding. Actually, it has excess production capacity, caused partly by foreign and partly by domestic competition.

The government's reasons for not imposing more trade barriers on Japanese electronics

products are potent. For one, Japan is a fruitful market for many U.S. products and other industries would be hurt if we built more trade barriers and the Japanese replied in kind, (Japan does impose quotas and minimum quality standards on some consumer electronics products and is trying to control the flow of still cheaper products from Hong Kong and Okinawa). Second, the electronics industry is vital to Japan. It is a prime source of capital money to buy needed imports, employment and military strength. It would be foolish for our government to take any action that would materially weaken a strong ally in the Far East.

Our heart is with American companies that want protection against Japanese imports. But our mind is with those who feel that it is self-defeating to create trade barriers in an effort to solve domestic economic problems.

Coming In Our July 13 Issue

AUTOTESTING. Automatic checkout equipment is frequently required for today's complex systems, especially when the time that would be needed to test all circuits by manually operated instruments would be prohibitive. Assistant Editor Novotny has surveyed the latest trends and techniques in methods used to test systems, how checkout equipment is designed and made adaptable to varying needs and what changes are coming in new automatic checkout systems.

Another up-to-date report, by A. P. Heyman, of GE, gives first design details on a new parametric amplifier that tracked a space probe 70,000 miles.

COMMENT

More on Abbreviations

In his letter printed in the *Comment* column of your May 18 edition (p 4), Mr. Charles F. Roberts attacked the growing misuse of abbreviations, which you answered in your note by saying that space may be saved by such abbreviations.

May I add some comment to that question from the viewpoint of a non-American reader of your journal. I fully agree that it will always be necessary to use abbreviations and symbols in technical literature. However, a general rule should be kept, either by the author himself or by the editor of the journal. All abbreviations used should be standard abbreviations which, if necessary, can be looked up in some list of standards, preferably an internationally recognized list such as an I.E.C. (International Electrotechnical Commission) or an I.S.O. (International Standards Organization) list of standards.

Readers of American technical literature whose native tongue is not English (and especially not American) very often are at a loss to understand some abbreviations which may be in current use in the U. S. but which are in contradiction with internationally established practice and standards. I suppose that, for example, most European engineers will understand abbreviations like min for minute, μsec for microsecond (though international standards recommend μs in this case), va for volt-ampere (though international standards are in favour of VA instead), etc. These are all abbreviations which refer to units used by engineers in every country of the world.

A very different thing, however, is the use of abbreviations like those quoted by Mr. Roberts: *iff*, *spdt* (where I really do not know what is meant), *avc* and *prf*, which are simply derived from the corresponding American expressions. In view of the fact that American technical literature is more and more read by readers of other countries, I think it could at least be recommended to print in full length every expression of that kind the first time it appears in the text of an article, followed by the abbreviation in parenthesis (or the other way around, if this is preferred).

Another, still better, solution would be to give a list of the symbols and abbreviations used, just ahead of or underneath the article. Still another possibility, not so good but yet a way out, might be the publication of a list of abbreviations by the journal which could be kept and used by the reader, especially the foreign reader.

Above all, however, all this trouble about abbreviations and symbols once again shows the necessity of having international standards. Some personal experience in the field of international standardization has shown me that the relative importance of such questions has not always been recognized in the U. S. However, I think that the fact of our world getting smaller and smaller every day, and of international cooperation becoming more and more important, will induce a rapid change in that attitude.

H. OSWALT

Laboratory of the
Hasler Foundation
Zurich, Switzerland

A technical subcommittee of the Institute of Radio Engineers is now at work on a list of standard abbreviations for use in electronics that will enable readers to look up unfamiliar ones. The foreword to the standard echoes reader Oswalt's admonition against overuse of abbreviations. The watchword is "When in doubt, spell it out."

Still More on Abbreviations

May I add my vote to that of reader Charles F. Roberts.

In his case, he understands the abbreviations. Too often, I do not. It is a poor showing for my BSME degree, but to me *iff* stands for "identification, friend or foe." And does *spdt* mean "stupid people don't think"? I recognized *avc* instantly as "all value cash," or is it Russian, meaning "any vacancies, comrade?"? That *prf* throws me completely, unless it refers to Roger Maris and means "position, right field."

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Cooling Capacity:
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—25°C with 200 mw load
Heat Sink Capacity: 3 watts
Input Power: 3.5 amps at 0.85 VDC

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SINGLE STAGE COOLER
Cooling Capacity:
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—31°C with 50 mw load
Heat Sink Capacity: 3 watts
Input Power: 7 amps at 0.4 VDC

Model 094447
TWO-STAGE CASCADE COOLER
Cooling Capacity:
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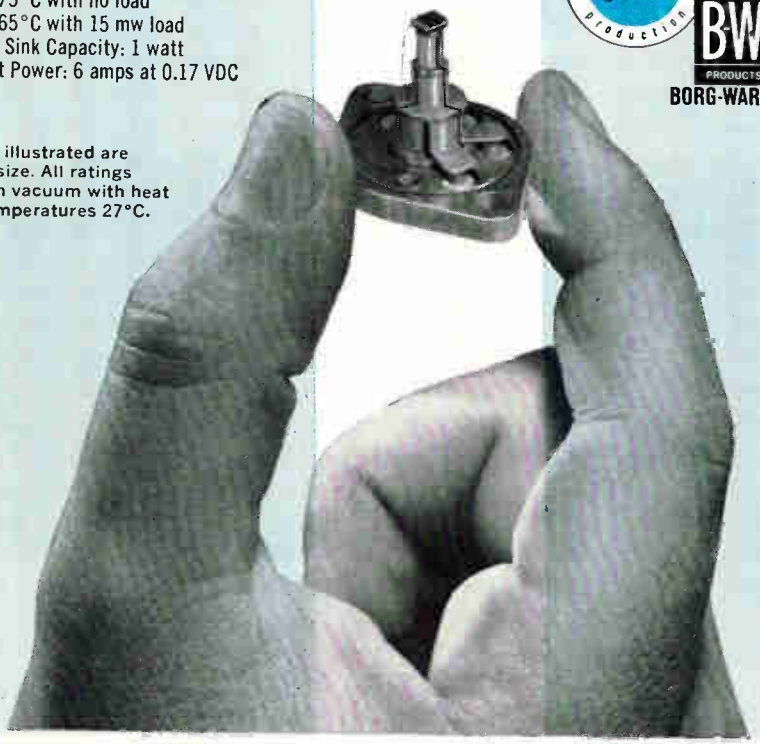
—50°C with 20 mw load
Heat Sink Capacity: 4 watts
Input Power: 3 amps at 1.2 VDC

Model 094520
THREE-STAGE CASCADE COOLER
Cooling Capacity:
—75°C with no load
—65°C with 15 mw load
Heat Sink Capacity: 1 watt
Input Power: 6 amps at 0.17 VDC

Models illustrated are actual size. All ratings taken in vacuum with heat sink temperatures 27°C.



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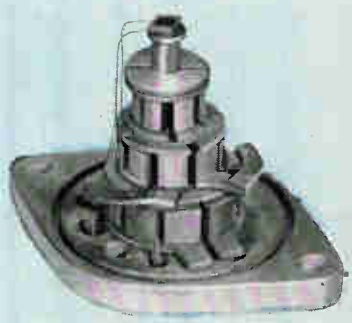

Model 094438
FOUR-STAGE CASCADE COOLER
Cooling Capacity:
—87°C with no load
—78°C with 15 mw load
Heat Sink Capacity: 12 watts
Input Power: 20 amps at 0.6 VDC
Can be provided complete with heat sink, blower, motor, and heat exchanger.

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plug-in programming for each individual column, code options with plug-in column cards

Fast data transfer

takes just 2 msec; prints up to 5 lines per second

Flexible BCD input

1-2-2-4 BCD input is standard; dual input available

all yours with this new hp 562A SOLID STATE DIGITAL RECORDER

SPECIFICATIONS

Printing Rate: 5 lines/sec. maximum

Column Capacity: To 11 columns (12 available on special order)

Print Wheels: 12-position, 0 through 9, a minus and a blank (Many special character wheels available from stock)

Driving Source: Parallel-entry 4-line BCD, 1-2-2-4. Other codes available on plug-in cards. Source reference voltages establish "0" and "1" states, which may be as much as 150 v above or below ground. "1" state 4 to 75 v above "0" reference. Driving power approx. 30 μa into 270,000 ohms

Print Command: ± pulse, 20 μsec or greater in width, 6 to 20 v

Hold Signal: (Available for each data source) —7 v to +15 v and +15 v to —7 v

Transfer Time: 2 msec

Paper Required: Standard 3" roll or folded

Line Spacing: Single or double, adjustable

Size: Cabinet, 20¾" x 12½" x 18½"; Rack, 19" x 10½" x 16⅞" deep behind panel

Price: hp 562A, 11 digit printer with six logic cards, $1,625.00 (cabinet), $1,600.00 (rack mount). 12th print wheel, additional logic cards, analog output optional

7087R

New, solid state hp 562A Digital Recorder prints digital data on 3" paper as fast as 5 lines per second, each line containing up to 12 digits. The instrument incorporates a unique data storage unit for each digit column that allows the data source to transfer data to the recorder in just 2 milliseconds, after which the source is free to collect new data.

Besides the standard parallel-entry 4-line BCD code (1-2-2-4), you can easily use other 4-line codes just by substituting plug-in column cards. Ten-line code operation (without data storage feature) is also available with plug-in cards.

Further, hp 562A accepts dual input (optional) and prints data simultaneously from two unsynchronized sources. A "patch panel" permits programming these two separate, unsynchronous inputs (even if coded differently) in any manner. Combinations of plug-in column code cards and "patch panel" column programming give complete flexibility in both dual-source data acquisition and data print positioning.

Analog output for high-resolution strip chart and X-Y recording is available as an extra-cost built-in feature of the 562A or through the new hp 580A Digital-Analog Converter, a separate solid state, high-precision instrument.

Designed for use with solid state and vacuum tube counters, Model 562A is ideal for a wide variety of individual and system applications. Call your hp representative today.

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2087

ELECTRONICS NEWSLETTER

Microwave Power Transmission Now Practical

WIRELESS TRANSMISSION of power through microwave transmitters and receivers is now practical and economically feasible for some applications, reports Purdue University. A program begun at Purdue in 1960 under Air Force sponsorship has achieved 60 percent efficiency in converting transmitted microwave energy into useful electrical energy.

Purdue says present techniques could be used to transmit power to satellites for changing orbital directions and powering radio and tv equipment.

No new hardware is required, according to Purdue. Standard tubes and semiconductor devices are used. Efficiency was raised from the 30 percent attainable a few years ago to 60 percent by optimizing diode circuits. Maximum power converted by a single circuit is 40 watts. This can be increased by paralleling circuits, and by further circuit and components improvements. It was pointed out that microwave tubes generating 200 Kw to 400 Kw are expected to become available at a cost of $10 a kilowatt.

The 60 percent conversion efficiency was attained by a team of investigators headed by E. M. Sabbagh, professor at the School of Electrical Engineering.

Peace Pipe Being Lit By FCC and TV Makers

NEW YORK—Morris Sobin, chairman of EIA's consumer products division and president of Olympic Radio said last week at an EIA symposium that industry would comply with the all-channel tv legislation despite initial objections by EIA. He pointed out, however, that most manufacturers have just introduced their new lines and will need more time to start changing assembly methods.

"We have our marching orders," said Edward E. Taylor, president of Motorola Consumer Products, "so let's go after this new market aggressively. Competition will provide the spur."

Indications that initial FCC specifications for all-channel sets will be flexible was reflected in a speech by Senator Gale W. McGee (D.-Wyo.). FCC appears to be relying on competition to guarantee quality. McGee said he was sure FCC would make every effort to effect the changeover with minimum disturbance to inventories, marketing and manufacturing.

Meanwhile, in Washington, FCC and manufacturers began a series of meetings to discuss the technical aspects.

To Track Booster, Use Hemispheric Laser Beam

PASADENA — Electro-Optical Systems, Inc., says that a highly accurate rocket booster tracking system could be built around a ruby laser beacon carried by the rocket. The proposal resulted from a six-month feasibility study sponsored by NASA.

The beam from a single 20-joule laser would be diverged into a 180-degree hemisphere by cassegranian lens and fiber optics bundles. The laser would flash every 10 seconds.

Ballistic cameras now used on the Atlantic Missile Range would be pointed to Cape Canaveral. After locking onto the beam, a photomultiplier tracker would point the cameras. The beam's monochromaticity would be exploited by interference filters. High-speed camera shutters, programmed to open as the laser flashed, would minimize background light.

The hemispheric beam would enable several ground stations to track the booster. The company says maximum practical daylight tracking distance would be 500 miles.

Navy Defends Award of Contract without Bidding

WASHINGTON—The Navy told a House Armed Services investigations subcommittee that it has "reaffirmed" plans to award a contract to Collins Radio for production of 641 uhf AN/PRC-41 radio sets (p 12, June 22). The contract has been delayed for a few months pending a Navy review of criticism by Rep. Earl Wilson (R.-Ind.) over the Navy's failure to seek competitive bids. Wilson charged that a bid by Arvin Industries was 34 percent lower.

Kenneth E. Belieu, assistant secretary of the Navy for installations and logistics, told the subcommittee the equipment is urgently needed and that Collins, the developer, would produce the sets "in the shortest possible time." Any other producer, he said, took "many months longer to deliver."

J. C. Cruden, of the Office of

Complexity Isn't Progress, Says Air Force

WASHINGTON—The electronics industry is being "engulfed" by a "disease" that confuses gadgetry and complexity with progress and invention, said Brockway McMillan, assistant secretary of the Air Force for R&D, at the IRE's military electronics convention last week.

He criticized the "notion that the 'best' design is the one with the most additional unimportant functions and the greatest growth potential." He blamed the military for "specifying complicated equipment, or failing to recognize that there may be simple and less elegant ways to solve the problem."

McMillan said the Pentagon is considering more use of performance specifications in R&D contracts and detailed specifications or a typical design for "clarifying the intent." Contractors would be encouraged by bonuses to reduce cost and complexity

Naval Materiel, said that a review of the two bids showed that "Arvin's proposal did not completely cover the job to be done, that major items were omitted or underestimated by Arvin, and that Collins' proposal will require adjustments downward in negotiations leading to the definitive contract."

Supply Agency Is Not Start of Military Merger

WASHINGTON—Rep. Porter Hardy (D.-Va.), chairman of a House Armed Services subcommittee investigating the trend toward unification in the Defense Department, last week questioned the legality of the Defense Supply Agency created for centralized procurement of common use items (p 12, May 25, and p 28, Jan. 19).

Hardy implied that the agency was a step toward eventual merger of the services. Defense Secretary McNamara denied that he plans such a merger. The agency was created under a 1958 law authorizing single-agency supply activities.

Despite the challenges of Hardy and other unification critics in Congress, DSA's future appears safe. Strong support is being given the agency by other congressmen, notably House Speaker McCormick who, with Rep. Thomas B. Curtis (R.-Mo.), introduced the measure authorizing DSA.

Microcore Mosaics Form New Computer Memories

MICROFERRITE techniques will be used in a family of high-speed computer memories to be sold by RCA's Semiconductor and Materials division. Processing speed will be up to 2 million bits a second. Experimental units able to process 10 million bits a second have been built at RCA Labs.

They consist of small, two-hole ferrite squares assembled in flat mosaics and interconnected by evaporated metal paths. Small hole diameters and the use of impulse switching for changing magnetic field polarity around the holes provide the high speed, RCA says.

Initial commercial units will have capacities in multiples of 32 30-bit words. Typical drive requirements will be 350 ma for read pulse, 250 ma for partial write pulse and 70 ma for digit pulse.

Britain Considers Switch To 625-Line TV Standard

LONDON—A gradual changeover from the 405-line tv standard used in Britain to the European 625-line standard was recommended last week by a government advisory committee. The committee, headed by Sir Harry Pilkington, was set up in 1960 to consider the future of radio and tv in Britain.

The committee recommends two new uhf channels be allowed, one for BBC and one for the Independent Television Authority, operating at 625 lines. Existing BBC and ITA vhf stations would continue on 405 lines until the majority of viewers have 625-line receivers, then these stations would also switch to 625 lines.

The committee also recommended establishment of color tv service in two or three years at 625 lines. Which color system will be used has not been decided. Radio broadcasting was found adequate, but the committee recommended BBC operate local community stations financed by revenues from existing licenses.

FAA Still Looking for Anticollision Equipment

WASHINGTON — Federal Aviation Agency will sponsor a government-industry symposium July 12 and 13 on airborne equipment to help prevent midair plane collisions. A broad cross-section of the electronics and aviation industries have been invited to participate in the Washington meeting to review anticollision research and development work, outline accomplishments to date and discuss future plans. Since 1958, FAA and seven contracting firms have been seeking a solution to the problem for both light and heavy aircraft. A range-altitude type system developed by Bendix Radio is currently being tested at FAA's Atlantic City research installation.

In Brief . . .

HOUSE Commerce Committee has approved a resolution allowing FCC to authorize power above 50 Kw in clear-channel radio stations.

PAY TV broadcasts were begun last Friday by WHCT, Hartford, Conn. Broadcasts are decoded at the set by a Zenith decoder. The station hopes to increase number of subscribers, now 300, to 4,000 or 5,000 by the end of the year.

EIA REPORTS transistor shipments and revenue declined 3 million units and $3 million, to 19.6 million and $25 million, in April.

NUCLEAR power source in Transit-4A satellite had its first anniversary in space last Friday. It had produced 23,650 watt-hours of electricity, could keep going for decades, AEC said.

TV CAMERA and other sensors, slaved to an infrared tracker, have been installed on an Air Force plane to watch spacecraft reentries. Camera was built by Philco.

SYLVANIA plans to curtail germanium alloy transistor production, step up output of germanium mesa, silicon planar epitaxial types and integrated circuit.

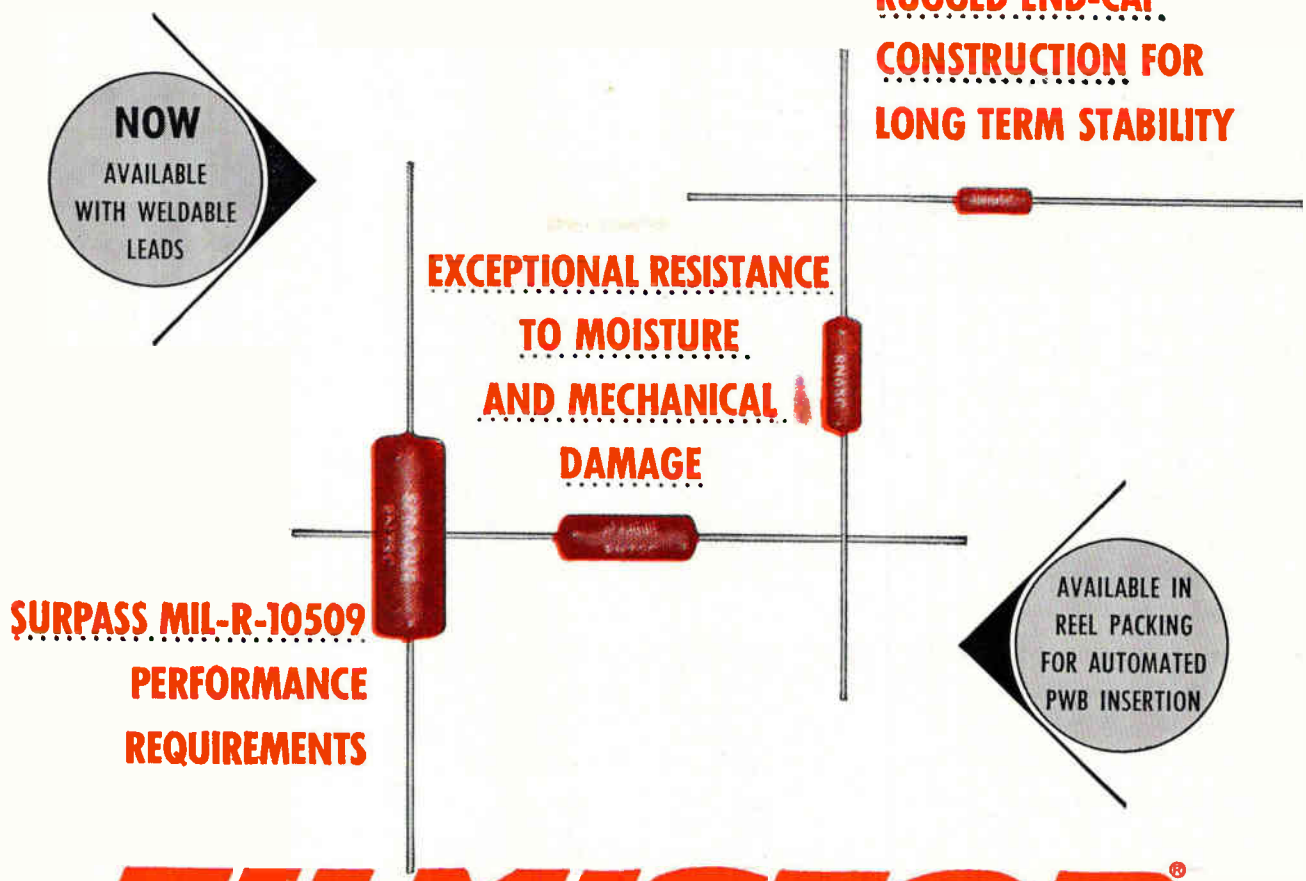
AEROSPACE Industries Association will support the trade expansion bill now before Congress.

NASA'S DIRECTOR of reliability will outline its viewpoint at a reliability training conference sponsored by IRE-PGRQC and ASQC next week at Princeton, N. J.

DALMO VICTOR reports it got $6.8 million in military radar antennas and magnetic system orders last month.

ORTRONIX has received $3.9 million in Signal Corps contracts for mobile area communications systems and shelters.

GENERAL Services Administration has ordered $2.4 million in radiation monitors from Victoreen.



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Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity.

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Filmistor Metal Film Resistors, in ⅛, ¼, ½ and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509D, Characteristics C and E. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 35 Marshall Street, North Adams, Mass.

For application engineering assistance write:
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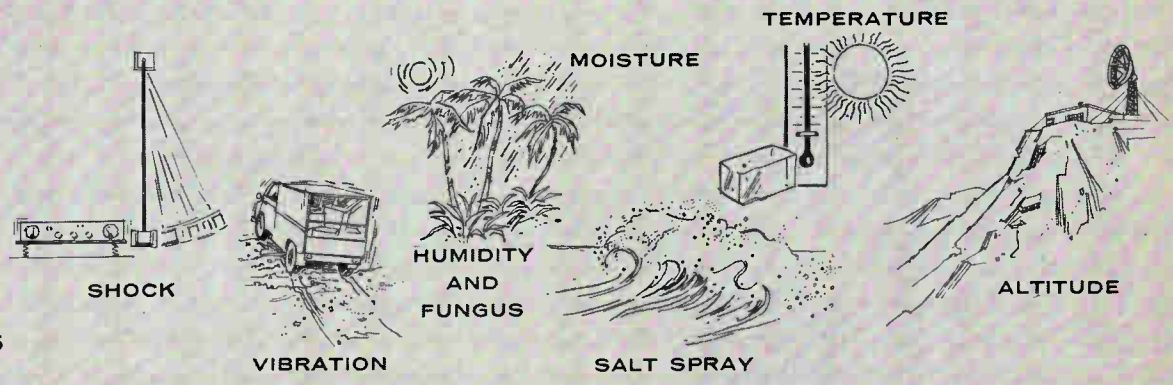

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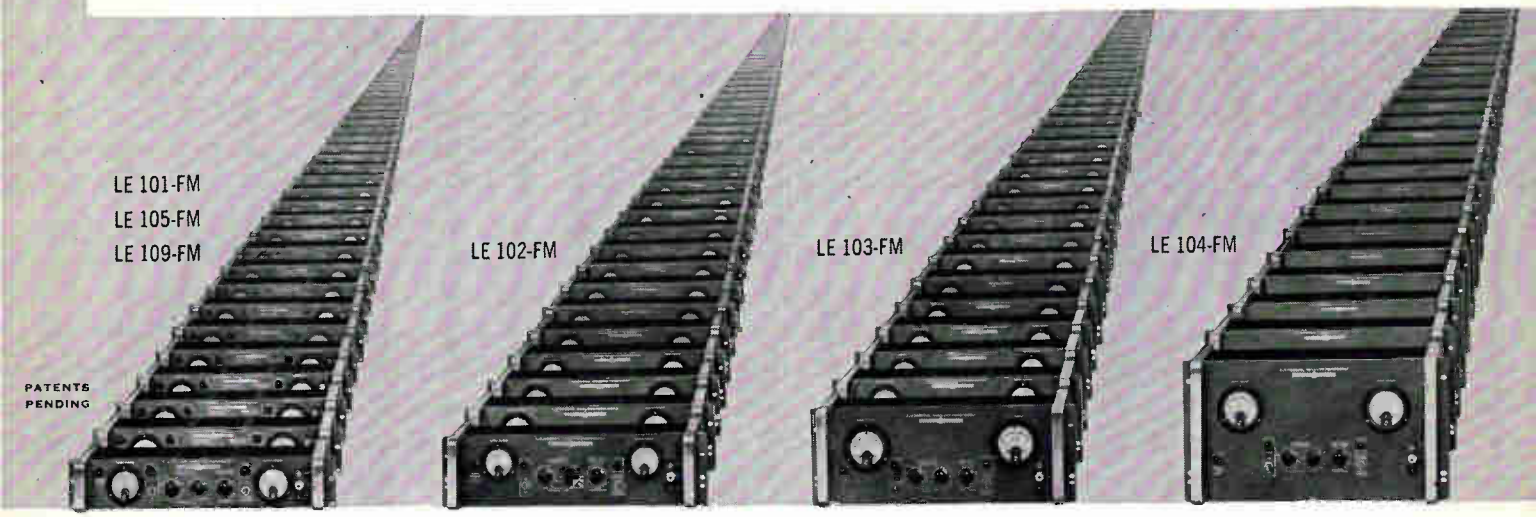

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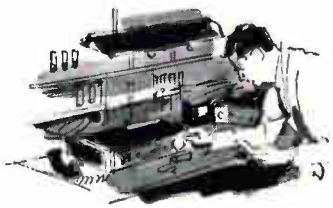
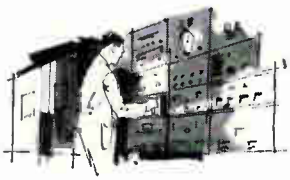
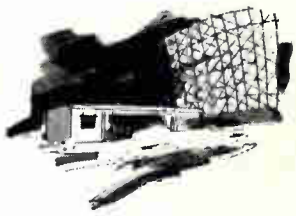


LABORATORY



INDUSTRIAL



MILITARY APPLICATIONS

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New England Regional Office: 275 Boston Post Road, Marlboro, Massachusetts • Phone: Code 617, HUntley 5-7122
Middle Atlantic District Office: 515 Broad Hollow Road, Huntington, L. I., New York • Phone: Code 516, MYrtle 4-4200
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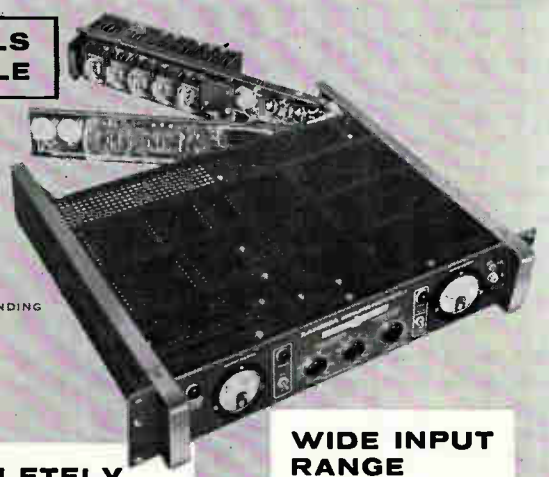
by automatic switchover.

6 MODELS AVAILABLE



PATENTS PENDING

COMPLETELY PROTECTED
against—short circuit and electrical overload; input line voltage transients; excessive ambient temperatures. No voltage spikes due to "turn-on, turn-off" or power failure.

WIDE INPUT RANGE
Wide input voltage and frequency range —105-135 VAC, 45-66 CPS and 320-480 CPS in two bands selected by switch.

REMOTELY PROGRAMMABLE AND CONTINUOUSLY VARIABLE
Voltage continuously variable over entire range. Programmable over voltage and current range.

OTHER FEATURES

- Adjustable automatic current limiting.
- 0°C to +50°C ambient.
- Grey ripple finish.
- Ruggedized voltmeters and ammeters per MIL-M-10304B on metered models.

5 Year Guarantee

5-YEAR GUARANTEE

covers all Lambda Power Supplies including LE Series models

Every Lambda power supply sold since 1953 has been backed by Lambda's 5-year guarantee, which covers workmanship and materials (except for tubes and fuses).

Visit
LAMBDA
at the Wescon Show
Booths 3421-3422.

LE SERIES
CONDENSED TENTATIVE DATA

DC OUTPUT (VOLTAGE REGULATED FOR LINE AND LOAD) [1]

Model	Voltage Range	Current Range	Price [2]
LE101	0-36 VDC	0- 5 Amp	$420
LE102	0-36 VDC	0-10 Amp	525
LE103	0-36 VDC	0-15 Amp	595
LE104	0-36 VDC	0-25 Amp	775
LE105	0-18 VDC	0- 8 Amp	425
LE109	0- 9 VDC	0-10 Amp	430

(1) *Current rating applies over entire voltage range.*
(2) *Prices are for nonmetered models. For models with ruggedized MIL meters add suffix "M" to model number and add $40 to the nonmetered price. For metered models and front panel control add suffix "FM" and add $50 to the nonmetered price.*

REGULATED VOLTAGE:

Regulation (line) ..... Less than .05 per cent or 8 millivolts (whichever is greater). For input variations from 105-135 VAC.

Regulation (load) ..... Less than .05 per cent or 8 millivolts (whichever is greater). For load variations from 0 to full load.

Transient Response
(line) .... Output voltage is constant within regulation specifications for any 15 volt line voltage change within 105-135 VAC.

(load) .... Output voltage is constant within 25 MV for load change from 0 to full load or full load to 0 within 50 microseconds of application.

Remote Programming ... 50 ohms/volt constant over entire voltage range.

Ripple and Noise ..... Less than 0.5 millivolt rms either positive or negative terminal grounded.

Temperature Coefficient.. Less than 0.015%/°C.

DC OUTPUT (CURRENT REGULATED FOR LINE AND LOAD) [3]
Current range 10% to 100% rated load for entire voltage range. Full specifications upon request.

AC INPUT ..... 105-135 VAC; 45-66 CPS and 320-480 CPS in two bands selected by switch.

OPERATING AMBIENT TEMPERATURE AND DUTY CYCLE..... Continuous duty at full load 0°C to +50°C (122°F) ambient.

OVERLOAD PROTECTION:
Thermal ..... Thermostat, reset by power switch, thermal overload indicator light front panel.

Electrical:
External Overload Protection ..... Adjustable, automatic electronic current limiting circuit limits the output current to the preset value upon external overloads, including direct short, thereby providing protection for load as well as power supply. Current limiting settable from 10% to 110% of load.

METERS:..... Ruggedized voltmeter and ammeter to Mil-M-10304B specifications on metered models.

CONTROLS:
DC Output Controls .. Coarse and fine voltage adjust and current adjust on front panel for models with suffix "FM", all other models same controls are mounted in rear.

PHYSICAL DATA:
Mounting..... Standard 19" rack mounting.

Size..... LE101, LE105, LE109 3½" H x 19" W x 16" D
LE102, 5¼" H x 19" W x 16" D
LE103, 7" H x 19" W x 16½"D
LE104, 10½" H x 19" W x 16½"D

WRITE FOR COMPLETE CATALOG
CIRCLE 11 ON READER SERVICE CARD

WASHINGTON OUTLOOK

NONPROFIT CONTRACT SALARY CEILINGS

REVELATION THAT the government is studying ways to put ceilings on salaries of high-paid defense contracting executives has stirred up lots of scare talk in industry. Officials in the Budget Bureau, in charge of the study, say the scare talk is exaggerated.

The proposed salary restrictions would apply to a very limited number of executives: mostly to those with nonprofit research institutions working full-time on R&D contracts which have been awarded without competition and whose salaries are directly chargeable to the military under cost-reimbursement clauses.

This means that executives whose salaries are paid out of their company's fee or profit are not involved. Neither are those working on projects which have been awarded through competition or which are under fixed-price provisions.

As things stand now, the salary schedules of executives on noncompetitive, cost-type research contracts have to be approved by contracting officers. The Budget Bureau wants to set uniform standards on such salaries, however, to keep the pay "comparable" to salaries paid elsewhere. The Bureau is not concerned with salaries paid on competitive contracts that, officials say, already have "built-in controls set by the market place."

MIDWEST LOSING DEFENSE BUSINESS

NEW PENTAGON REPORT documents how burgeoning missile and electronic procurement over the past decade has dramatically shifted the regional distribution of defense contracts.

The rate of prime contracts to the five major midwestern states, for example, has declined from an average annual level of $8.7 billion during the Korean War to $2.6 billion. Overall, the region's share of the defense procurement dollar has dropped 57 percent. New York, Pennsylvania, and New Jersey are also down in the volume of contracting, but not as much as the midwest.

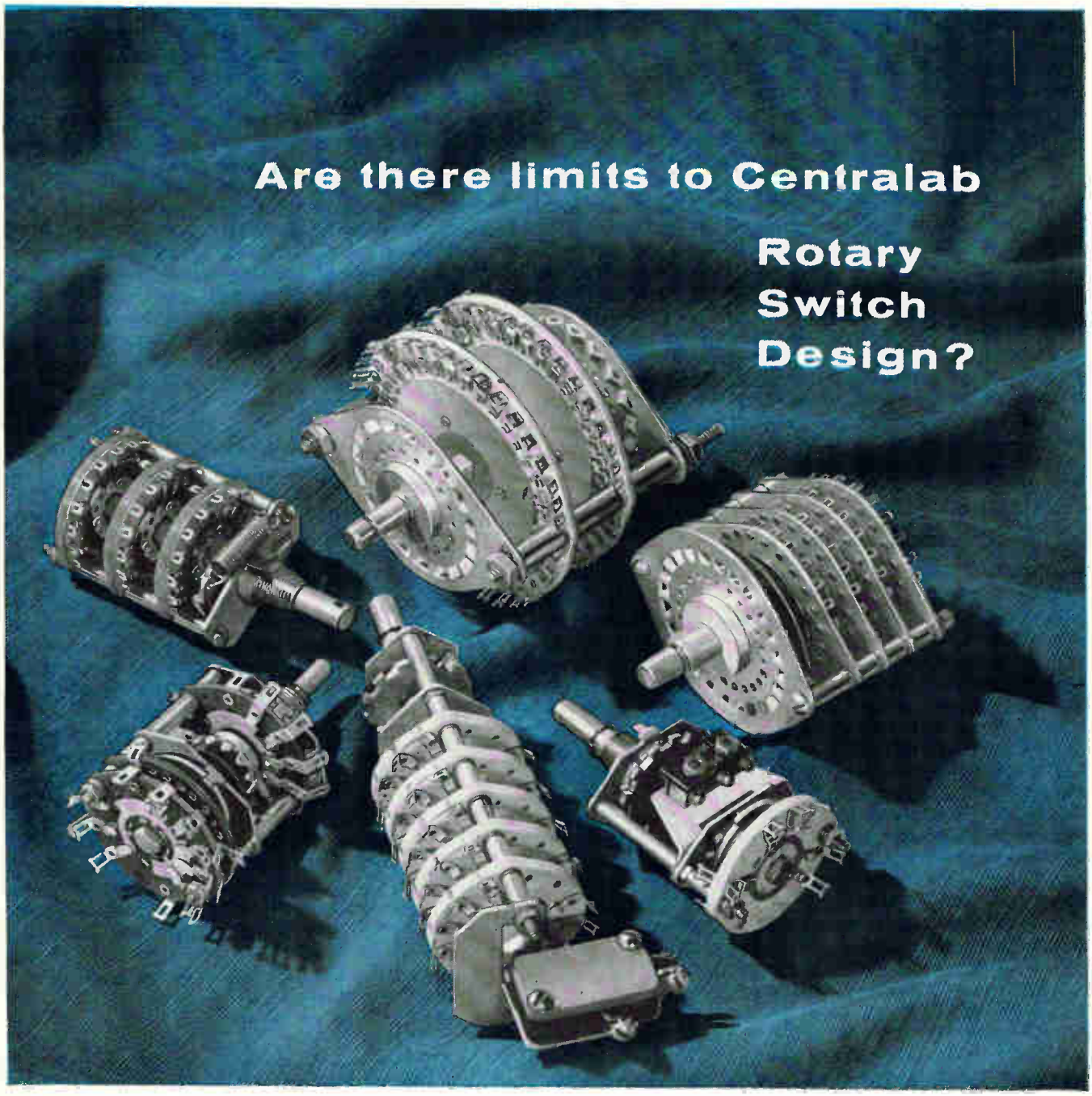
The big gainer has been California, which has zoomed from 13.6 percent of prime contracts to 23.9 percent. Massachusetts, Texas, Colorado and Florida have also gained.

REASON: MILITARY CONTRACTS FOLLOW R&D

ACCELERATION OF THE TREND is anticipated. R&D contracting is particularly concentrated. About 90 percent of R&D contracts are centered in 12 states. This means, the Pentagon says, that follow-on production contracts are likely to go where the R&D work is now being done.

Behind the regional shifts are these factors: procurement of conventional ordnance (tanks, guns, etc.) has been cut from 50 percent of military buying to 12.4 percent; missiles have jumped from 0.5 percent of contracting a decade ago to 33.6 percent, and electronics rose from 11.2 to 18 percent. The R&D shares of missile contracting (57.9 percent) and electronics-communications (24.9 percent) are larger than for any other type of military hardware.

What this all boils down to is this: R&D activity, notably basic research by universities and non-profit institutions, lures manufacturing industry. The midwest, which has failed to diversify into missiles and electronics and to engage heavily in R&D to as great an extent as other regions, is rapidly losing stature as a center of defense industry work, the report indicates.

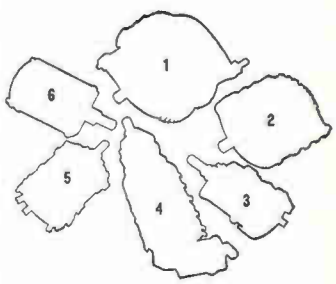


Of course—but they are much broader than you might think. The illustrated units are just a few of the difficult and unusual switches that CENTRALAB has been called upon to design.

What kind of special switch do you need? CENTRALAB engineers can modify an existing type, or design an entirely new switch to solve your problems.

For immediate attention, write directly to CENTRALAB's Switch Sales Manager, outlining your problem.

1. Switches 36 circuits progressively in missile check-out application. Used with stepping relay in limited equipment area. Glass silicone insulation.
2. Sub-miniature 24 position switch provides 50% space reduction over conventional switch construction. Has rugged, accurate indexing for long life. Glass epoxy insulation.
3. Low voltage switch with auxiliary high voltage snap action switch which breaks heavy load to rotaty switch during switch cycle. Has guarded detent.
4. 5 pole, 9 position low voltage switch with locking action make and break on integral snap action switch. Snap action switch breaks load to rotary switch during switch cycle.
5. Dual concentric switch in which inner shaft operates rotors of all 3 sections while outer shaft operates rotor on front section independently. Used in aerial photography equipment.
6. 3 pole, 18 position unit with 6 positions on each section. Has high torque for positive positioning of contacts. Glass epoxy insulation. Used in ground support equipment.



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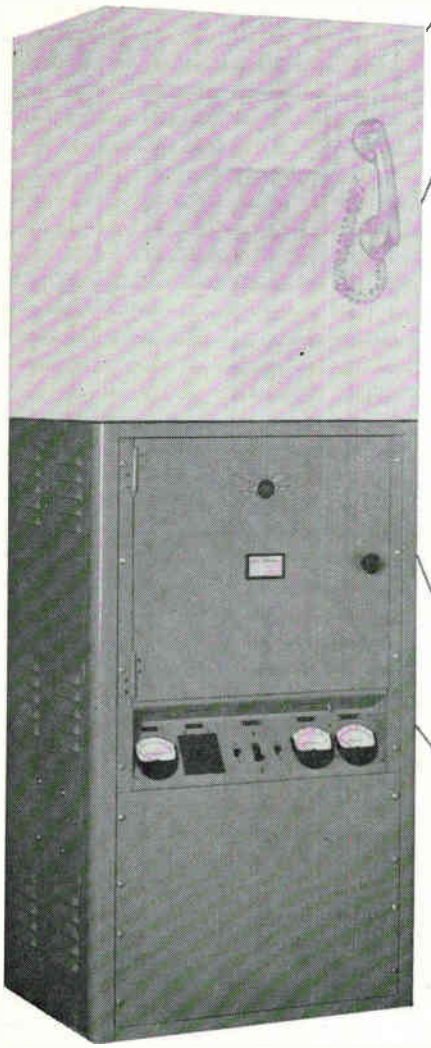

USE AEROCOM'S AMPLIFIER FOR MORE COMMUNICATION POWER!

AEROCOM'S Linear Amplifier used with conventional low power SSB transceivers for excitation, provides power output of 1000 watts PEP, continuous service. The SSB exciter should have at least an output of 65 watts PEP to obtain maximum output of the amplifier.

The Model 10LA amplifier is housed in a cabinet (22" Wx14¾" Dx36¾" H) which can serve as a base for conventional SSB exciter, or amplifier may be placed a short distance away from the associated exciter, if necessary for convenience.

Frequency range of 10LA is from 2 to 20mc, covered in 6 bands. Up to 4 independent non-simultaneous channels are provided. These four channels are selected externally by exciter channel control. One tuning unit is provided for each frequency specified up to maximum of four.

The 10LA amplifier is designed to work into a 50 ohm coaxial feed line. One output coaxial receptacle, common to all four channels, or 4 output coaxial receptacles (one for each channel) are available; each channel normally requiring its own antenna. For multi-channel operation with 1 antenna it is recommended that Aerocom Model ATU-410 antenna coupler be used.

A built-in directional coupler provides monitoring of output power and SWR. Grid current, plate current, filament voltage and high voltage are metered.

Harmonic output attenuation: second harmonic is at least 55 db down and higher harmonics are at least 70 db down. Noise level is 40 db below 1000 watts PEP output. Distortion products, in two-tone test, are at least 35 db down, depending on characteristics of exciter.

This linear amplifier, like all Aerocom equipment, is ruggedly constructed to give long trouble-free service. Additional information and technical data on request.

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Varian Associates' family of pulsed driver traveling wave tubes is the most complete in the microwave industry. These state-of-the-art tubes are available in power ranges from 5 kW to 50 kW, to satisfy requirements of modern radar systems. Tube construction employs contra-wound helix or ring-bar circuits to permit efficient operation.

Varian's driver TWT family covers a wide range of varying operational requirements. All have wide bandwidth and flat gain characteristics. Most are periodic permanent magnet focused, some are solenoid focused for use in phased array systems or other special applications. Varian pulsed TWT's feature high duty cycles, long pulse capability, high efficiency.

If your special radar requirements demand high-performance driver TWT's, Varian has (or can design) the tube for you. For additional information, contact Tube Division.

Tube Type	Frequency Range (Gc)	Peak Power (kW)	Average Power (watts)	Pulse Width Microseconds	Gain (db)	Focusing	Modulation
VA 134B	0.5-0.6	5	350	600	35	PPM	Grid
VA 137C	0.87-1.00	5	350	600	45	PPM	Grid
VA 133D	1.25-1.40	5	350	600	50	PPM	Grid
VA 131E	1.25-1.70	25	150	35	35	PPM	Grid
VA 131B	1.25-1.70	50	200	30	40	PPM	Grid
VA 128C	2.9-3.35	5	15	10	30	PPM	Grid
VA 139A	5.20-5.90	5	10	10	50	Solenoid	Cathode Pulsed

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You have one week to balance this

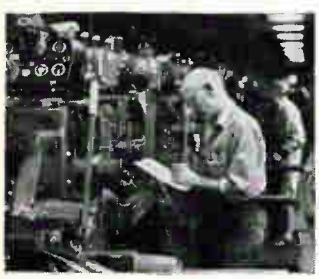
Walk down this Farmall tractor assembly line and you'll see 50 distinct products in the making. All tractors, but all different. Some farm, some industrial. Diesel, gasoline, LP and high altitude engines. Different transmissions, different hydraulic systems, different steering mechanisms. Different accessories. To suit the customer.

You'd think this would make line balancing a problem. But it doesn't—not with an IBM Computer helping out. Production line balancing with an IBM Computer has helped International Harvester's Farmall Works shave one to two weeks off the task. They now balance the line for a complete schedule change in less than a week.

This frees key technical people for more creative work. It helps International Harvester act faster to meet the needs of a changing market. It helps them use men and machines more efficiently... allocate manpower more accurately.

It probably can help you. Ask your IBM representative about it.

mixed line—can you do it?



■ You zone your assembly line, identify jobs, give a precedence to each. The job list provides the input data for all work assignment by the computer.

■ The computer starts the assignment process, determines the best set of jobs for one operator, prints out the detailed information.

■ As all jobs in one zone are assigned, the computer reads in the job data for the next zone, repeating the process until the line is balanced.

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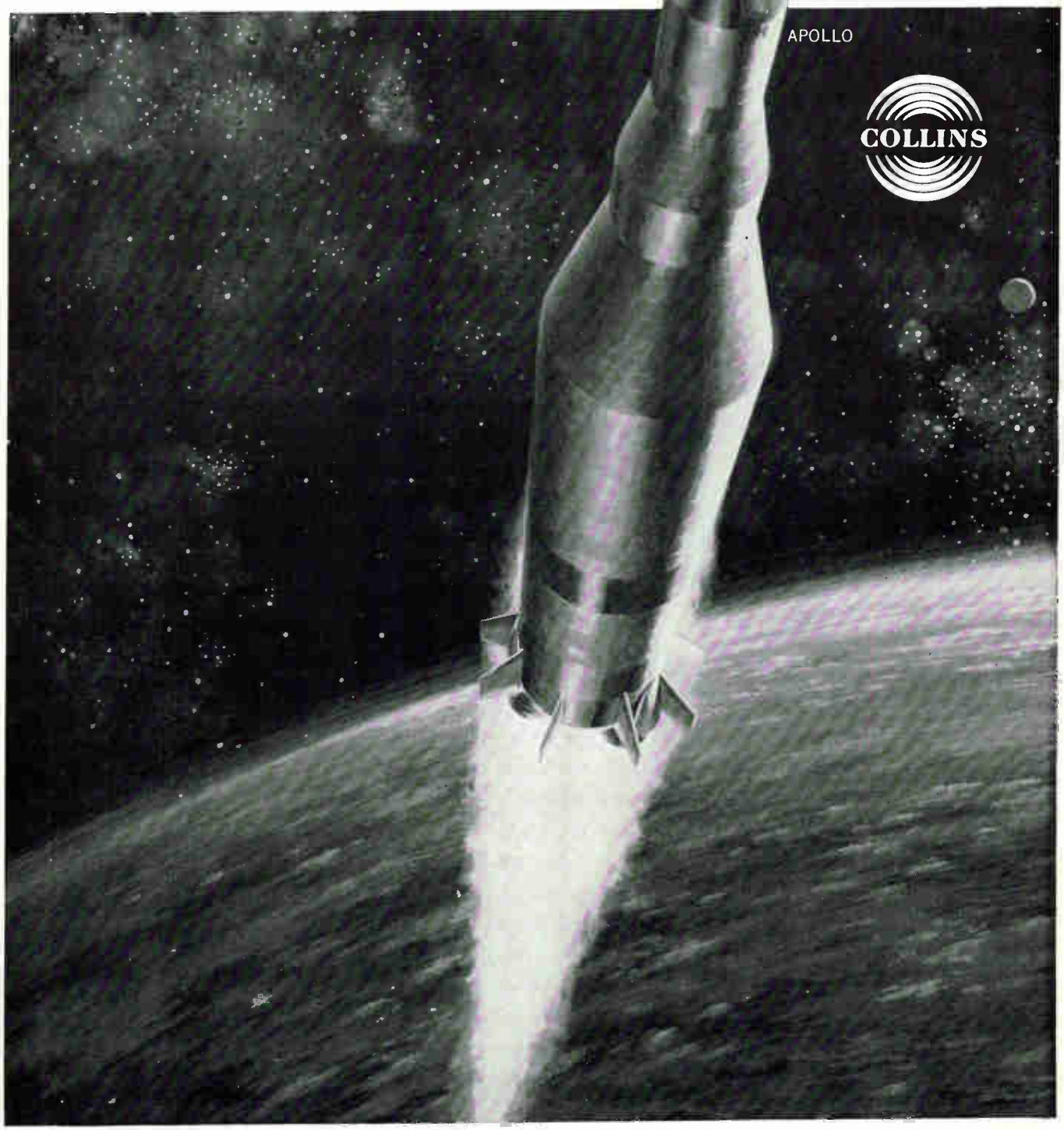
Every American voice from space — from the X-15 and Mercury — has been carried by Collins communications. Now, with the accent on reliability, Collins is readying extensive systems for the next and most ambitious U.S. space effort, NASA's Apollo manned lunar spacecraft. ☐ To further extend this leadership in space communications, Collins requires specialists in HF, VHF, UHF equipment, digital communications, spacecraft antennas, TV, radar, modulation techniques, tracking and ranging, information theory, and ground systems. If interested in this challenge, write Mr. L. R. Nuss, Cedar Rapids, Iowa; Mr. C. P. Nelson, Dallas, Texas; Mr. E. Montano, Newport Beach, California.



The QUALITY line of ROTARY COMPONENTS

CLIFTON PRECISION PRODUCTS CO., INC.

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Prices of Electronic Stocks Were More Erratic

But our issues are expected to bounce back faster

By THOMAS EMMA
Associate Editor

ELECTRONICS STOCKS performed more erratically than those of general industry during the recent period when stocks fell to their lowest prices in years. Despite this, there are indications that electronics prices may show an earlier recovery than others.

The business outlook for our industry continues to be sound despite the stock situation. Backlogs continue high, new contract awards are still coming in and industry projections on sales and earnings are optimistic.

Commentators within both the electronics industry and the financial community are beginning to speak of some of the positive aspects and trends arising from the recent stock shakeout: more realistic profit margins, healthier capital-raising conditions and more accurate price/earnings ratios.

PROFIT MARGINS—Profit margins have been declining for industry in general. In the first quarter of this year they fell to 4.3 cents per dollar of sales as compared with 4.8 cents in the last quarter of 1961. The 4.3 rate, however, is equal to the average of 1961 and 1960.

Electronics industry profit margins have also fallen somewhat recently, although no quantitative figures exist in federal statistical sources of information.

The Securities and Exchange Commission, which tabulates profit and sales information for industry, includes electronics with electrical machinery. In this grouping, sales for first quarter 1961 are given as $7,023 million, with profits of $206 million. In the fourth quarter 1961, sales rose to $8,083 million and profits to $350 million. In the first quarter of 1962 sales dipped $7,767 million and profits dropped to $274 million.

These figures, which represent sales and profits after taxes for publicly held companies, give some indication of our industry position as compared with all industry.

Sales for all industries amounted to $82,592 million, and profits to $2,900 million, in the first quarter of 1961. In the fourth quarter of 1961, sales rose to $95,154 million and profits to $4,609 million. The all-industry figures for 1962's first quarter also show a drop, to $92,833 million in sales and $4,004 million in profits.

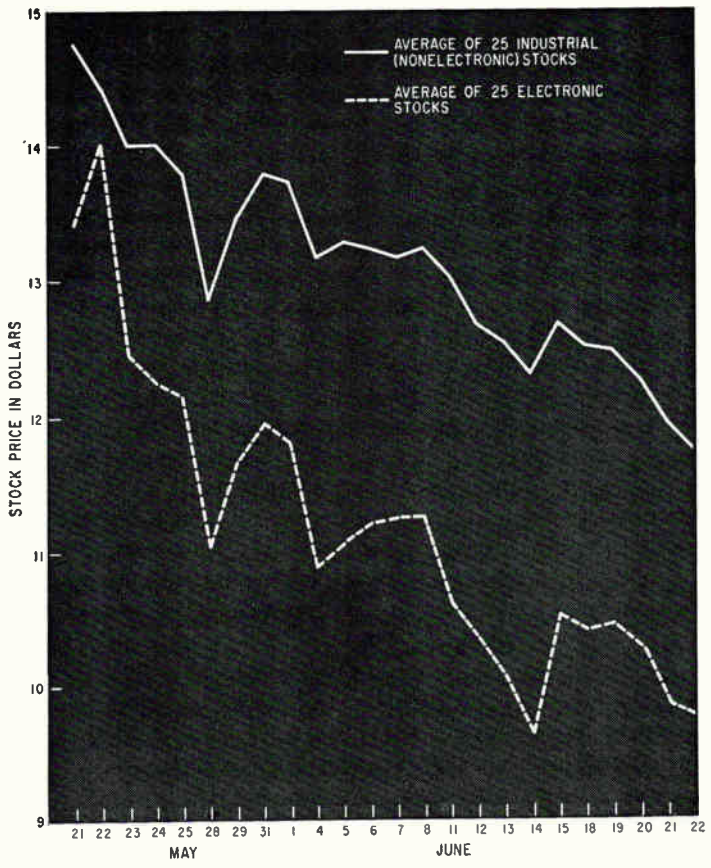
"Profit margins for different segments of the electronics industry will be affected in different ways," according to Donald Siebert of Electronics Capital Corp.

"Some manufacturers of nonproprietary items have been handling orders at greatly reduced profit margins just to keep busy. In many cases this has been based on the philosophy that indications of high volume and backlog in the annual reports and other financial statements would retain the interest of the investing public.

"In cases where this philosophy translated itself into lower and lower profit margins, the idea just didn't work.

"Companies with proprietary products and sound financial philosophies haven't had to rely on such financial devices and are likely to see their stock prices recover in much better order," Siebert says.

VULNERABILITY — Chance for continued downturns for the electronics industry is lower than for



ELECTRONICS STOCKS *fluctuated more widely in price than industrial stocks during late May and June. Stocks used in deriving these curves had appeared consistently among the most active in both groups through 1961*

During the Market's Shakeout

industries based primarily on consumer products, in the opinion of William Prior, a partner in Hammond, Kennedy & Co.

"Consumer-oriented businesses are likely to see continued effects of the indecision and lack of confidence the investing public is feeling. The electronics industry, on the other hand, is built to a major extent on a stable base of government contracts, giving an advantage not many other industries have at this time."

RAISING CAPITAL—Ways of acquiring capital are due for some changes as far as the electronics industry is concerned. From all indications, public underwritings are likely to remain scarce for some time. Public underwriting firms have been withdrawing applications filed with SEC, counseling clients to bide their time and in some cases turning a deaf ear to companies wanting to talk about going public.

Jerome Kohlberg, Jr., a partner in Bear Stearns, told ELECTRONICS "There's a hiatus now. A new set of values are coming into play and maybe preferred stocks and bonds will see a more prominent role in financing. Common stock investors have learned a sharp lesson and, hopefully, the market has run out of customers who buy first and think later. Let's hope so anyway."

A commentator for one major brokerage house describes the market for equity financing as "soft".

"Capital is available," he adds, "but not through public underwritings. Issues right now would be hard to sell even though the electronics industry is sound. We deal with some of the more sizable companies in the electronics industry and they agree with us that they should wait before initiating public underwritings."

Hardie Shepard, a partner in Payson & Trask, says "there's no problem in the electronics industry.

"It's just that in the past some companies had too easy a time in obtaining public underwritings and then the investing public let common sense run away from them. Many truly sound electronics companies enjoyed price-earnings ratios that were higher than industry averages, and deserved these ratios.

"The trouble started," Shepard thinks, "when companies not really meriting such price-earnings ratios began seeing them. There'll be a recovery, but for some of the one-time glamor stocks the old saying that 'a month of boom takes a year of recovery' may apply."

MERGER PATTERNS — Merger patterns are not likely to be affected, so far as the number of transactions that take place go. However, mergers and acquisitions that were in process at the time of the decline will be reexamined.

"This situation will kill some deals and make possible others which would at one time have been unfeasible," said one commentator.

Lower stock prices will certainly affect transactions based on exchanges of shares. Many preliminary merger talks are now being based on statements like "we will sign on the dotted line if the price of the stock doesn't go below X dollars before the closing date."

SBICs—Several analysts indicate a belief that current financial conditions will mean more business for Small Business Investment Companies (ELECTRONICS, p 26, Aug. 25, 1961). Many SBICs have been sitting tight on portions of their available capital, preferring to maintain a reserve in the form of government bonds rather than risk funds in an uncertain market. With the avenue of public offerings frequently closed off by present conditions, there will be a growing number of applications and transactions with SBICs, according to some Wall Streeters.

Summing up a good portion of financial opinion about the present state of the electronics industry is the comment from one financier, "Technology as a creater of wealth is still strong, market conditions notwithstanding."

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Visually inspect . . . instrument check and replace faulty parts with ease

Dielectric Gel permits both visual and instrument inspection of potted circuits and components. Poured as a liquid, Dielectric Gel fills all voids, then sets up as a transparent, heat-stable, resilient mass. No significant stresses or exothermic heating develops during cure. Even the most delicate electronic components are safe. Instrument probes can be inserted and withdrawn repeatedly without damaging the outstanding dielectric properties of this Dow Corning silicone potting material.

Circuit Repair is easy to accomplish. Simply cut away the gel surrounding a defective component with knife or scissors. After the circuit is repaired, simply pour new gel into the repaired area to restore original high quality protection.

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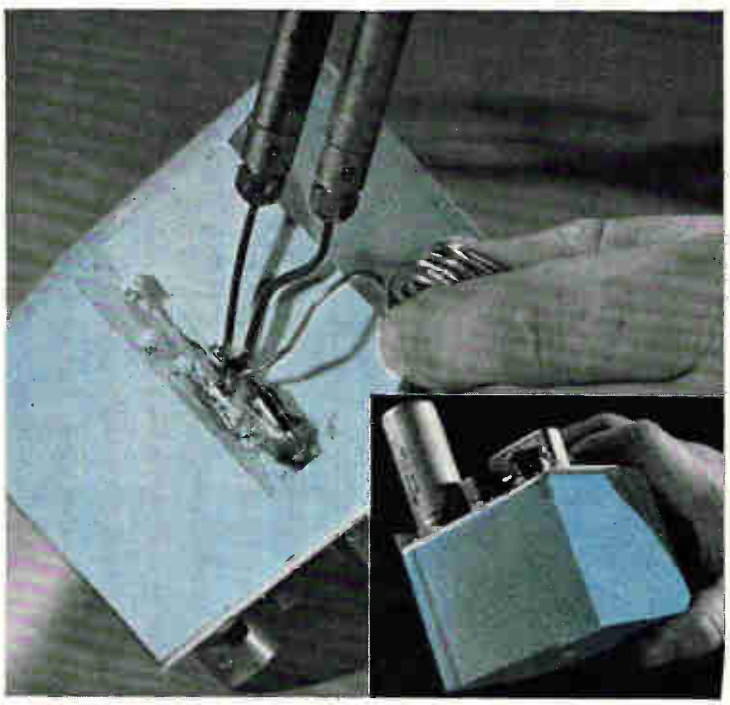
Silastic RTV, Dow Corning's fluid silicone rubber that vulcanizes at room temperature, is available in several variations. Select the best one suited for your application or processing requirements. All have excellent dielectric properties, low water absorption, stability under extreme temperatures, resistance to thermal cycling and aging. The newest Silastic RTV cures in thick sections in 24 hours at 77 F. Variations in thickness have no significant effect on curing rate or material uniformity.

Vulcanized Patch. Defective parts embedded or encapsulated in Silastic RTV . . . even where thick sections are used . . . can be replaced. The cured Silastic RTV is cut away with a knife, the component replaced, and new Silastic RTV applied to the repair area. The fresh material bonds to the original, restoring the encapsulant's integrity.

CIRCLE 291 ON READER SERVICE CARD



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Write Dept. 3907, Dow Corning Corporation, Midland, Michigan.

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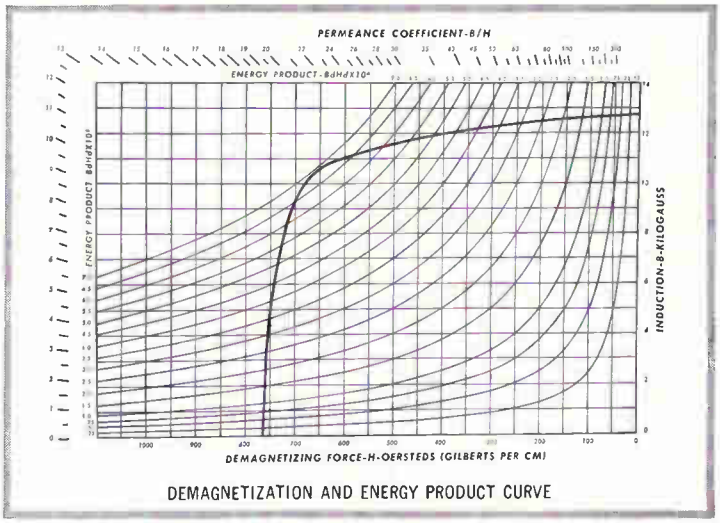

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Alnico V-7 produces more magnetic energy per unit volume or weight than any of the Alnicos — 7 million BH max. This space age Alnico allows considerable reduction in magnet size and weight without sacrificing energy. Typical applications are: lightweight ground and airborne generators and alternators in a full range of frequencies; oscillographs, galvanometers, recording instruments, magnetometers and meters; and missile-borne guidance and recording equipment. Indiana General engineers — backed by over 50 years of permanent magnet application experience — are specialists in designing the right magnet for your application. Call or write for technical assistance to Indiana General Corporation, Magnet Division, Valparaiso, Indiana. **Ask for bulletin #350.**

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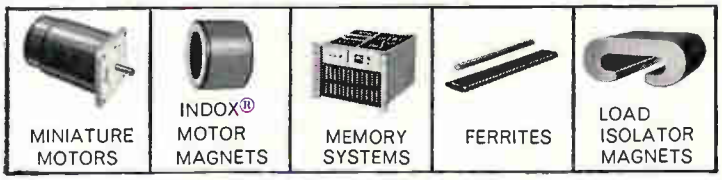


NEWS FROM
BELL LABORATORIES

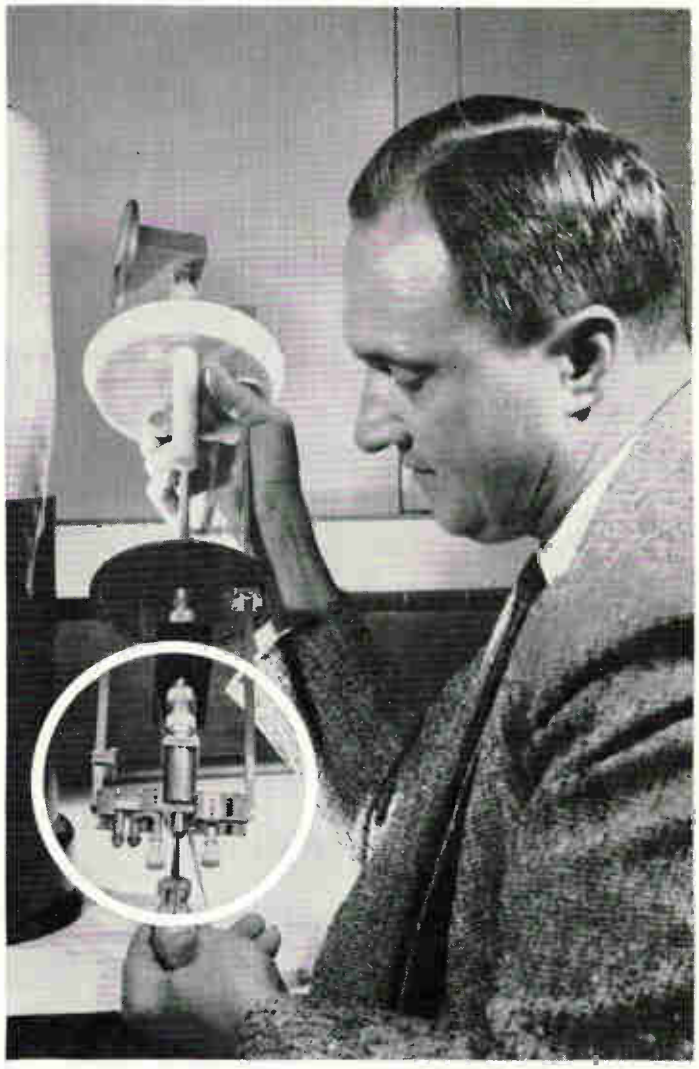
A simple, highly sensitive microwave amplifier

Bell Laboratories engineers have developed an extremely sensitive parametric amplifier which approaches the maser in sensitivity. Both will be used in experiments with Telstar, the Bell System's experimental communications satellite.

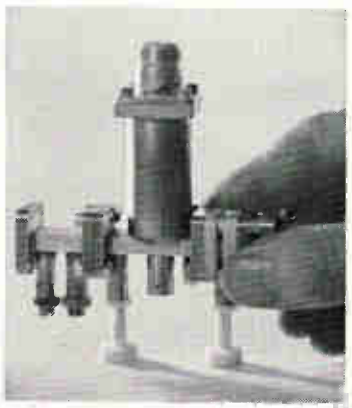
Heart of the parametric amplifier is a newly developed semiconductor diode with very low intrinsic noise. Previously, the sensitivity of such amplifiers at microwave frequencies was severely limited by the unwanted noise generated in their diodes. The new diode, no bigger than the eye-end of a needle, solved this problem.

Our engineers also devised new circuitry to stabilize precisely the output of the klystron (microwave generator) supplying power for the amplifier. To reduce further the intrinsic noise of the amplifier, they immersed the diode and its circuits in liquid nitrogen, utilizing a new cooling arrangement which economically maintains a low temperature for many days without attention.

The new amplifier fills a need in the communications field for a simple microwave amplifier of high sensitivity in applications for which the higher sensitivity of the maser does not justify its additional complication.



Bell Laboratories' Michael Chruney adjusts waveguide assembly (in circle) housing the diode. After adjustment the entire parametric amplifier will be immersed in liquid nitrogen in dewar at left. The new amplifier operates at 4170 megacycles (center of band) and provides an almost flat gain of 38 db over a 50-megacycle band with a noise figure of approximately 0.6 db.



Close-up of the waveguide assembly, in which Bell Telephone Laboratories' newly developed diode is located.

Heart of amplifier—a hermetically sealed gallium arsenide diode—is compared with eye of average-sized sewing needle.

BELL TELEPHONE LABORATORIES

World center of communications research and development

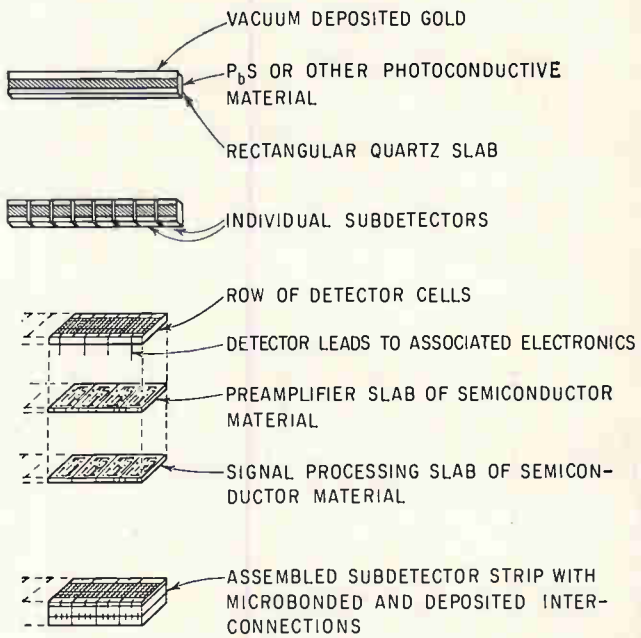
Designers See Space Guidance Systems

AEROSPACE MERGER

LOS ANGELES—*Proposed merger of the Institute of the Aerospace Sciences and the American Rocket Society was urged by L. Eugene Root, IAS president, at the IAS meeting. He said merger would eliminate much duplication of effort by two organizations having parallel purposes and activities.*

IAS and ARS officers are to review merger plans shortly. Members would vote this fall. If the plans go through, the new Institute of Aeronautics and Astronautics would be created on February 1, 1963. Combined membership of IAS and ARS is 30,000

Another proposal: radiation shields converting nuclear energy to power



MOSAIC GUIDANCE fabrication technique

LOS ANGELES—Plans for longer spacecraft missions have been steadily directing guidance component development away from inertial reference systems and toward optical guidance, it was reported in a survey paper on advanced mosaic guidance systems presented at the National Summer Meeting of the Institute of the Aerospace Sciences late last month.

Goal is an optical guidance system that will not require an expensive and complex inertial platform and high-accuracy sensors, said Eugene F. Lally, of Jet Propulsion Laboratory, and Mortimer Penberg, of Aerojet-General. Development of optical systems, they added, will be based on developments in visual and infrared sensors, thin-film and semiconductor network fabrication, and microminiature computers with high-capacity memories.

MAKING MOSAICS—Lally and Penberg described a method of fabricating mosaic guidance components that would reduce noise and the volume of detector channels. Arrays of photocells, each with its own solid-state, signal-amplifying, shaping and processing circuits, would feed an onboard computer as shown in the diagram.

The cells would respond to visual and infrared stimuli originating from stellar and planetary bodies. The stimulus information presented by the optics of the system to the image plane (the mosaic of cells) would then be refined to a signal useful for guidance.

To fabricate the primary components, photoconductive material is deposited on long, rectangular quartz strips 3 mils wide. Gold deposits mask off each side of the strip, leaving a center strip of photoconductive material 1 mil wide. Detector cells 1 mil wide are produced by etching and are bonded to a semiconductor substrate containing the information channels.

RADIATION SHIELDS — Other developments outlined at the IAS meeting include new methods of radiation shielding.

Space vehicle shielding may be provided by dipole-like magnetic fields using superconducting coils, said Robert F. Tooper and William O. Davis, of Armour Research Foundation. Shielding is necessary to protect crews from charged particles in space.

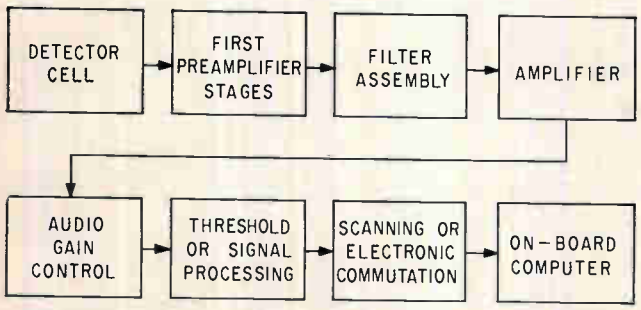
Regions of shielding obtained with a dipole magnetic field are dependent on the Störmer unit, C_{st}, as shown in the diagram. This length represents the radius of a circular particle orbit in the equatorial plane of a dipole, and is dependent on the total energy of the particle. Computations indicate that a dipole of moment 3×10^{11} gauss cm^3 over the equator of a sphere of 2 meters diameter will completely shield protons of energy less than 866 Mev and partially shield protons of energy less than 8.1 Bev.

Axially symmetrical regions are obtained by rotating the figure shown about the dipole axis.

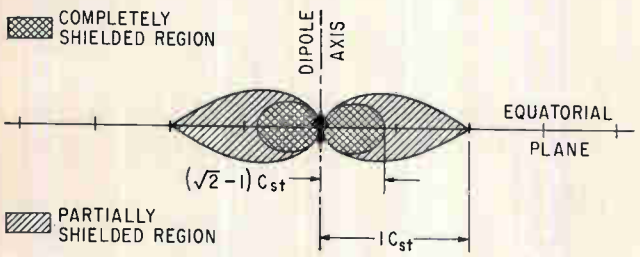
The discovery of materials that maintain their property of superconductivity in the presence of strong magnetic fields, such as the niobium-zirconium alloys and certain other niobium intermetallic compounds, has led to the possibility of magnetic shields.

Tooper and Davis feel this type of shield will lead to a significant payload weight saving. Disadvantages to be overcome include the continuous cooling power required, the vulnerability of the system to mechanical and electrical damage, and the effect of the strong mag-

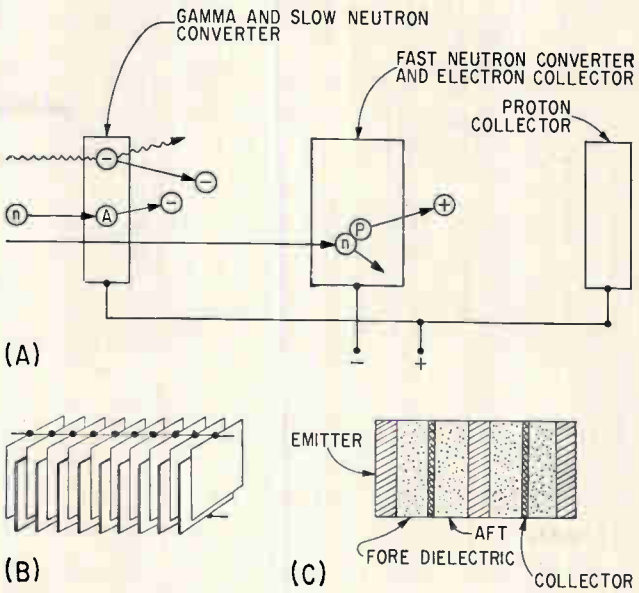
Turning into Mosaics of Optical Cells



SUBDETECTOR input and output electronics for mosaic guidance



MAGNETIC DIPOLE field shielding regions



RADIATION SHIELD to convert neutrons and gamma rays into electrical energy. Electrodes (A) may be arranged into stack of plates (B) or solid cell (C)

netic fields on instrumentation. This work is being supported by the Air Force.

ENERGY CONVERSION—A technique for converting escaping nuclear reactor radiation directly into electrical energy by an active shield was proposed by Bernard Raab, of Republic Aviation.

As illustrated, the shield would consist of three electrodes that could be stacked in plate or solid form to provide a conversion cell.

The first electrode, composed of a high-atomic-number material, would be a gamma and slow neutron converter that would emit negative particles and have a positive charge. Compton scattering converts gamma rays to electrons. The target, of high-absorption cross-section, converts slow neutrons by transmuting them to beta-decaying isotope with a short half-life.

The second electrode, composed of a low-atomic-number material, collects the negative particles. Fast neutrons would penetrate to this electrode and scatter protons from this thin, hydrogenous target, increasing this electrode's negative charge. A third electrode, a high-atomic-number material, collects the protons and has a positive charge.

A 1,500-watt solar thermionic power system, based on state-of-the-art components, was reported by T. J. McCusker, of Thompson Ramo Wooldridge. The system includes thermionic generators, orientation systems to keep the generators aligned with the sun, storage batteries for use during the shaded portion of the orbit, power regulators for the system, and a system for deploying the generators.

A goal of one-year life is proposed for the system. McCusker feels that neither the thermionic converter nor the battery has fully demonstrated this capability.

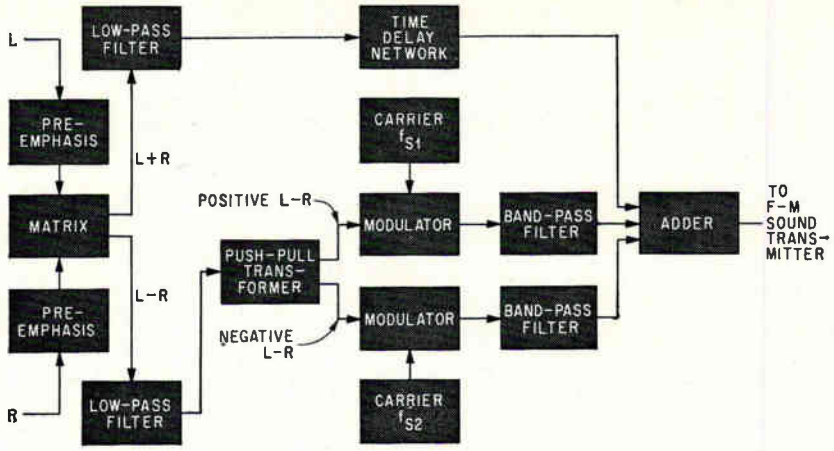
PECAN—The Pulse Envelope Correlation Air Navigation (Pecan) system, which enables airborne measurement of velocity and ground-track, was described by James Salerno, of Diamond Ordnance Fuze Laboratories. The system correlates variations in pulse radar terrain returns received by two antennas, mounted fore and aft along the longitudinal axis of an aircraft. The two antennas receive identical return signals at a time differential determined by aircraft velocity.

Experiments support the feasibility of the Pecan system, Salerno said. Experimental data indicate that system errors may be less than 1 percent. Weight problems are expected to become negligible with the development of solid state signal processing circuits. Salerno pointed out that conversion from a modern pulse-type radio altimeter to the Pecan system would require only the addition of a third antenna and a signal processing package.

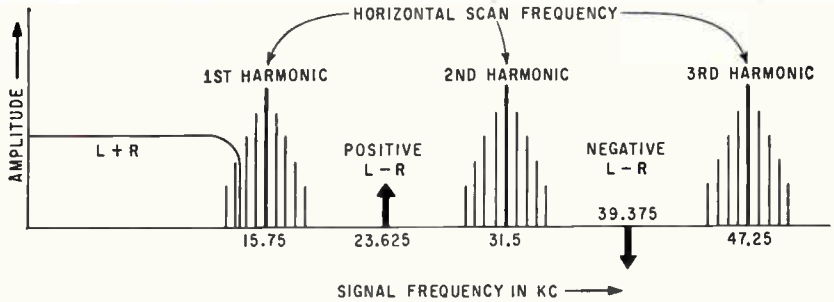
Bell Telephone System Hardening Its Arteries

EASTERN THIRD of a blast-resistant transcontinental cable system, running from Washington to New York, will be completed late this summer by the Bell Telephone System. Underground cables, amplifier stations and communications centers are designed to withstand all but direct nuclear hits.

The system will be completed to the west coast by 1964. Costing about $200 million, it will include 4,000 miles of coaxial cables, 900 amplifier stations and nine communications centers.



STEREO TV SOUND *system employs three information channels. L+R signal can be received on unmodified sets*



POSITIONING *of L+R and two halves of L—R signals in horizontal scan frequencies*

Latest Design Idea for Television Audio Stereo

Negative and positive portions are positioned in horizontal scan

DES PLAINES, ILL.—Stereo audio system for television considered by its designers as two years ahead of the consumer market was introduced at the IRE's Spring Conference and Television Receivers. Multipath interference tests of the system are being completed this summer by General Electric. Filing for approval will follow.

Other topics at the conference included the feasibility of using silicon planar transistors in tv receivers, ways of cutting cost by improved circuits and components and new transistor tuners for f-m radios and uhf tv (p 25, June 29).

R. W. Galvin, president of Motorola, urged those attending the conference to support passage in Congress of HR 11088, to help limit government patent activity to licensing. Attendance totaled more than 700 persons, over 100 more than last year.

TELEVISION—The tv audio stereo system, described by R. B. Dome, of GE, transmits three audio channels (see illustrations). The positive half of the L – R signal is positioned midway between the first and second harmonic of the horizontal scan (23.625 Kc). The negative half is positioned midway between the second and third harmonic (39.375 Kc). The L+R signal, is transmitted between 50 cps to 15 Kc, can be received by an unmodified receiver.

A noise-reducing system recombines the signals in a circuit containing coils and four diodes. Signal degradation would be about 23 db down from monaural—about the same as for f-m stereo.

John MacIntosh, of Fairchild Semiconductor, discussed the feasibility of using silicon planar transistors for a tv receiver. He said a circuit using 22 transistors and 13 diodes outperformed a 19-inch, 110-degree top-of-the-line tube version, except in small-signal modulation. Push-pull, r-f amplifier and common base operations more than equals tube performance, and further improvements are still to be expected, MacIntosh claimed.

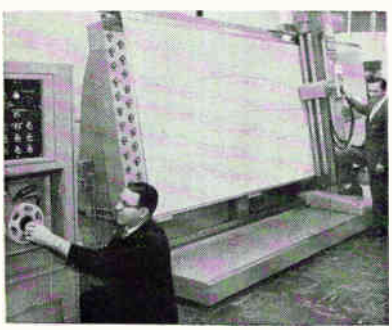
Significant economies without loss of performance or reliability can be obtained by toroid coils in vertical deflection yokes, reported Kenneth Fulton, of Motorola. He said a less costly 6FK6 tube and a smaller and more economical output transformer can be used. Transformer cost is cut 25 percent because the higher inductance of the toroid requires lower transformer inductance, for the desired time constant. Core size may then be reduced by ¾ by ¾ inch. A 140-volt

supply has proven adequate for 114-degree deflection in one configuration. Total power input of 7½ watts in one circuit and 9 watts in another is comparable with the 13 watts required for saddle yoke deflection. Tubes run cooler and more reliably, Fulton added.

Strap frame grid manufacturing techniques were credited with enhancing life and reliability of a new uhf tv local oscillator discussed by L. R. Maguire, Sylvania. Eliminating the possibility of intermittent grid-to-cathode shorts, the tubes are said to operate 17 percent cooler, due to reduced heater power and current drain.

RADIO — Post-alloy-diffused germanium transistors operating on voltages as low as 1 v were introduced in a two-transistor, f-m car radio tuner circuit by William King, Amperex. Permeability tuning is least susceptible to the auto's mechanical vibration. Signal sensitivities of 1.6 μv and 2.6 μv for 20 db and 30 db of quieting, with inherent power gains of 28 db and image rejections of 42 db, are attainable, he said. Diodes help counter overload, a leading trouble in transistor receivers. High cutoff frequency transistors, such as the padt 2N2494 connected in a common-emitter configuration as an r-f amplifier, deliver more power gain in the front end. A zener-regulated power source compensates for changes in tuning caused by variations in supply voltage and signal strength.

Robot Draftsman



NUMERICALLY controlled drafting machine built for General Dynamics/Fort Worth by Ekstrom, Carlson and Co. prepares design drawings and master lofting layouts. Rate is 10 linear feet a minute and accuracy is 0.005 inch over a 12-foot span

Loudspeaker Rating System Proposed

CHICAGO—Loudspeaker rating system for consumers and industrial buyers was proposed by Lincoln Walsh, of Walsh Engineering, at the Loudspeaker Industry Meeting late last month. The rating and color-coding system would tell customers three things about a loudspeaker: frequency range, acoustic power producing capacity, and a number which indicates general performance.

"The rating system serves primarily the customer by giving accurate information on the performance capabilities and limitations. It does not distinguish between products that are in the same performance range. It does point out the products that are in the category he wants," Walsh said.

The general performance number is the sum of scores on six tests: response uniformity, transient effects, distortion, diffusion of sound, efficiency or sensitivity, and listening quality (a test to be made by impartial judges). Measurements based on fundamental acoustic principles determine what quality rating any speaker receives.

The coding system uses different colors to indicate frequency range, and several kinds of symbols to indicate acoustical power capacity. The number of symbols indicates performance number. For example, five gold stars would indicate an excellent speaker with one watt of acoustical power capacity and a frequency range of 20 to 20,000 cops.

Walsh said that essentially the same form of quality rating system can be used for radio and television receivers and phonographs, whether monaural or stereo. In modified form it could be used to rate audio performance of tuners, amplifiers or pickups, he added.

Walsh's rating system started two months ago when the FTC asked Electronic Industries Association to develop a definition of hi-fi. EIA, in turn, asked its members to give their definition; they received 154 replies, of which Walsh's was one.

Another EIA meeting was to be held late in June to try to hammer out a definition of hi-fi "with which the industry can live," said one spokesman. This definition will be submitted to the FTC. As one member put it, "the problem is to develop a definition which will not be too stringent."

Portable Tv Recorder Uses Helical Scanning

NINETY-POUND, portable, closed-circuit tv tape recorder was demonstrated last month by Mach-Tronics, Inc., a newly-formed company in Mountain View, Calif. It employs the helical scanning principle, using two recording heads 180 degrees apart.

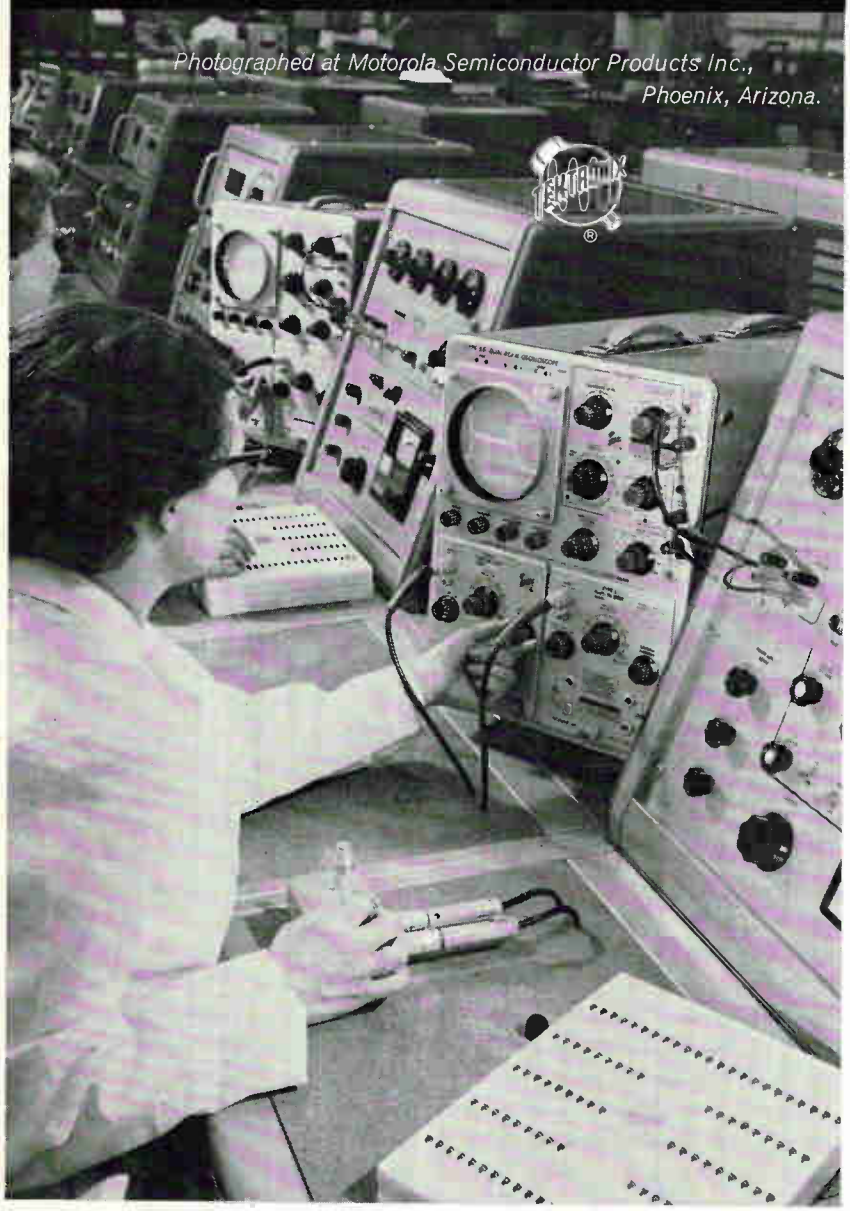
Some 96 minutes can be recorded on a 10½-inch reel of 1-inch tape running at 7½ inches a second. The company says video frequency response will be ±3 db from 30 cps to 3 Mc with reference to 100 Kc and will be down no more than 6 db at 3.5 Mc. Signal to noise ratio will be 40 db. Price, with an eight-inch tv monitor, is pegged at $10,800.

TV RECORDER *is also expected to find applications in cro and radar recording*

DISPLAYING

HIGH-SPEED SWITCHING

CHARACTERISTICS WITH A TEKTRONIX DUAL-BEAM OSCILLOSCOPE



Photographed at Motorola Semiconductor Products Inc., Phoenix, Arizona.

Type 551 Dual-Beam Oscilloscope

Here's one of many applications possible with the Tektronix Type 551 Dual-Beam Oscilloscope . . .

At Motorola Semiconductor Products Division in Phoenix, the Quality-Control Personnel rely upon accurate waveform displays from the Type 551 to verify total turn-off time of epitaxial Germanium and Silicon Mesa switching transistors. In this quality-control test, the upper trace on the oscilloscope shows the inverted input to a silicon saturated switching circuit, and the lower trace shows the output. Observing time-coincidence characteristics from the sharp dual-beam display, the operator can determine quickly and accurately if the Mesa transistors meet test specifications.

For your own dc-to-25 mc applications, consider the signal-handling ease and capabilities of this high-performance dual-beam oscilloscope.

By interchanging combinations of 16 letter-series plug-in units, you can equip the Type 551 for applications such as dual-beam pulse sampling . . . strain-gage and other transducer measurements . . . semiconductor-diode-recovery-time studies . . . differential-comparator work . . . as well as multiple-trace displays in most waveform-comparison analyses—and you can do it simply and dependably.

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TYPE 551 DUAL-BEAM OSCILLOSCOPE

(without plug-in units) $1850
Includes: Indicator Unit, Power Supply, 4 Probes, 7 other accessories.

Type L Plug-In Unit (as illustrated) . . . $ 210

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MEETINGS AHEAD

RADIO PROPAGATION COURSE, NBS and University of Colorado; NBS Boulder Laboratories, Boulder, Colo., **July 16-Aug. 3.**

RELIABILITY TRAINING CONFERENCE, IRE, ASQC; Princeton Inn, Princeton, N. J., **July 9-13.**

LUNAR MISSIONS MEETING, American Rocket Society; Pick-Carter and Statler-Hilton Hotels, Cleveland, Ohio, **July 17-19.**

MEDICINE & BIOLOGY DATA ACQUISITION AND PROCESSING, IRE-PGME, AIEE, ISA; Strong Memorial Hosp., Rochester, N. Y., **July 18-19.**

INTERNATIONAL SOUND FAIR, Institute of High Fidelity Manufacturers, Magnetic Recording Industry Assoc., et al; Cobo Hall, Detroit, **July 25-29.**

INDUSTRIAL RESEARCH CONFERENCE, Columbia University; Arden House, Harriman, N. Y., **Aug. 5.**

ENERGY CONVERSION PACIFIC CONFERENCE, AIEE; Fairmount Hotel, San Francisco, Calif., **Aug. 13-16.**

PRECISION ELECTRONIC MEASUREMENTS INTERNATIONAL CONFERENCE, IRE-PGI, NBS, AIEE; NBS Boulder Labs, Boulder, Colo., **Aug. 14-16.**

CRYOGENIC ENGINEERING CONFERENCE, University of California; at UCLA, Los Angeles, Calif., **Aug. 14-16.**

ELECTRONIC CIRCUIT PACKAGING SYMPOSIUM, U. of Colorado, et al; Boulder, Colo., **Aug. 15-17.**

AIRCRAFT & MISSILES CONFERENCE, ASQC; Benjamin Franklin Hotel, Seattle, Wash., **Aug. 16-18.**

APPLICATIONS & RELIABILITY SYMPOSIUM, Precision Potentiometer Manufacturer's Assoc.; Statler-Hilton Hotel, Los Angeles, **August 20.**

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., **Aug. 21-24.**

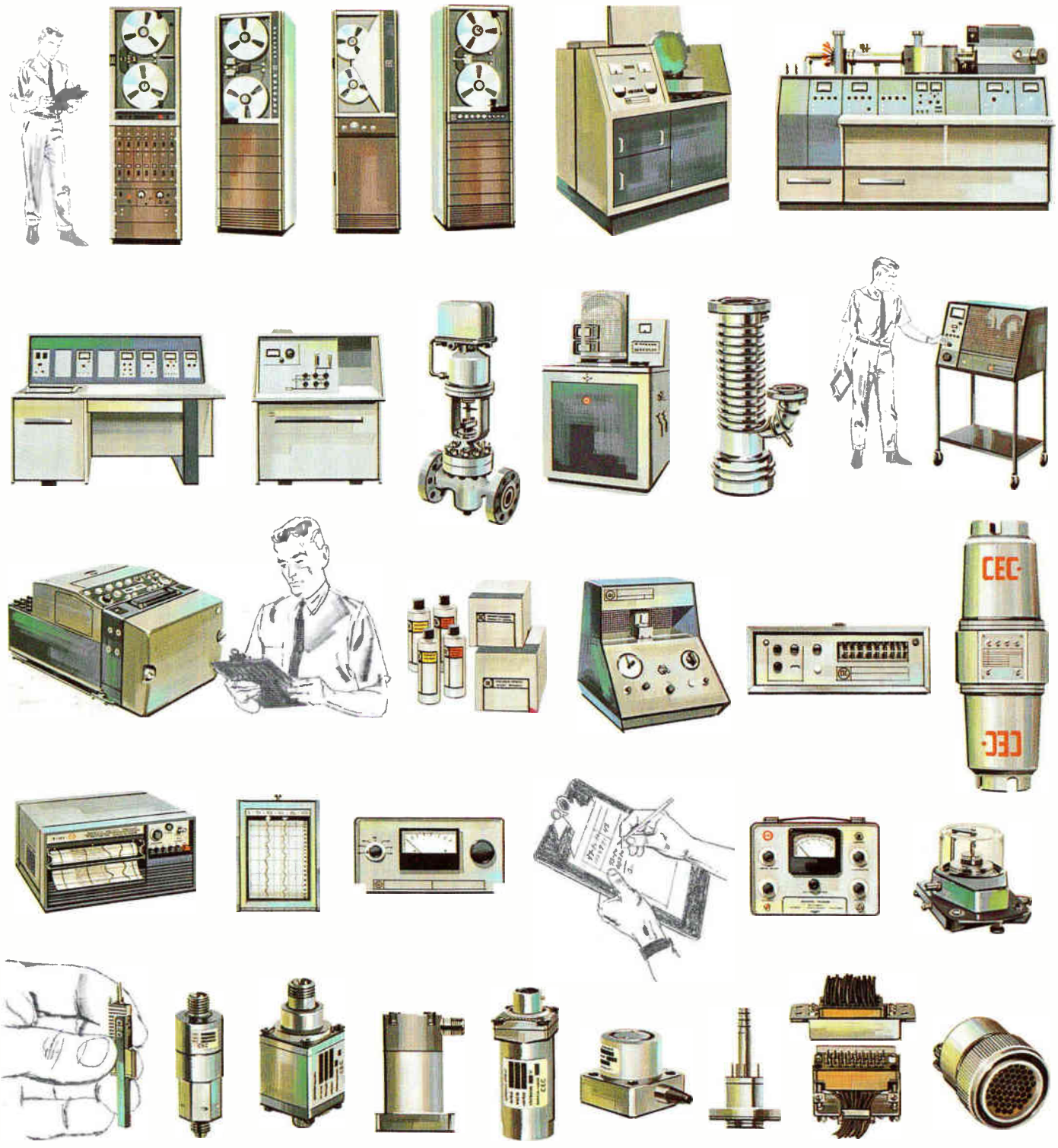
METALLURGY OF SEMICONDUCTORS; the American Institute of Mining, et al; Ben Franklin Hotel, Philadelphia, Pa., **Aug. 27-29.**

BALLISTIC MISSILE & SPACE TECHNOLOGY SYMPOSIUM, US Air Force and Aerospace Corp.; Statler Hilton Hotel, Los Angeles, **August 27-29.**

MAINTAINABILITY OF ELECTRONIC EQUIPMENT, EIA Engineering Dept. & Dept. of Defense; U. of Colorado, Boulder, Colo., **Aug. 28-30.**

ADVANCE REPORT

ULTRASONICS SYMPOSIUM, IRE-PGUE; *Columbia University, New York City, Nov. 28-30. Aug. 13 is the deadline for submitting 3 copies of a 200-word abstract to: R. N. Thurston, Technical Program Chairman, Bell Telephone Laboratories. Murray Hill, N. J. Particular emphasis will be given to microwave ultrasonics. but contributed papers are being sought in any of the various specialties of ultrasonics.*



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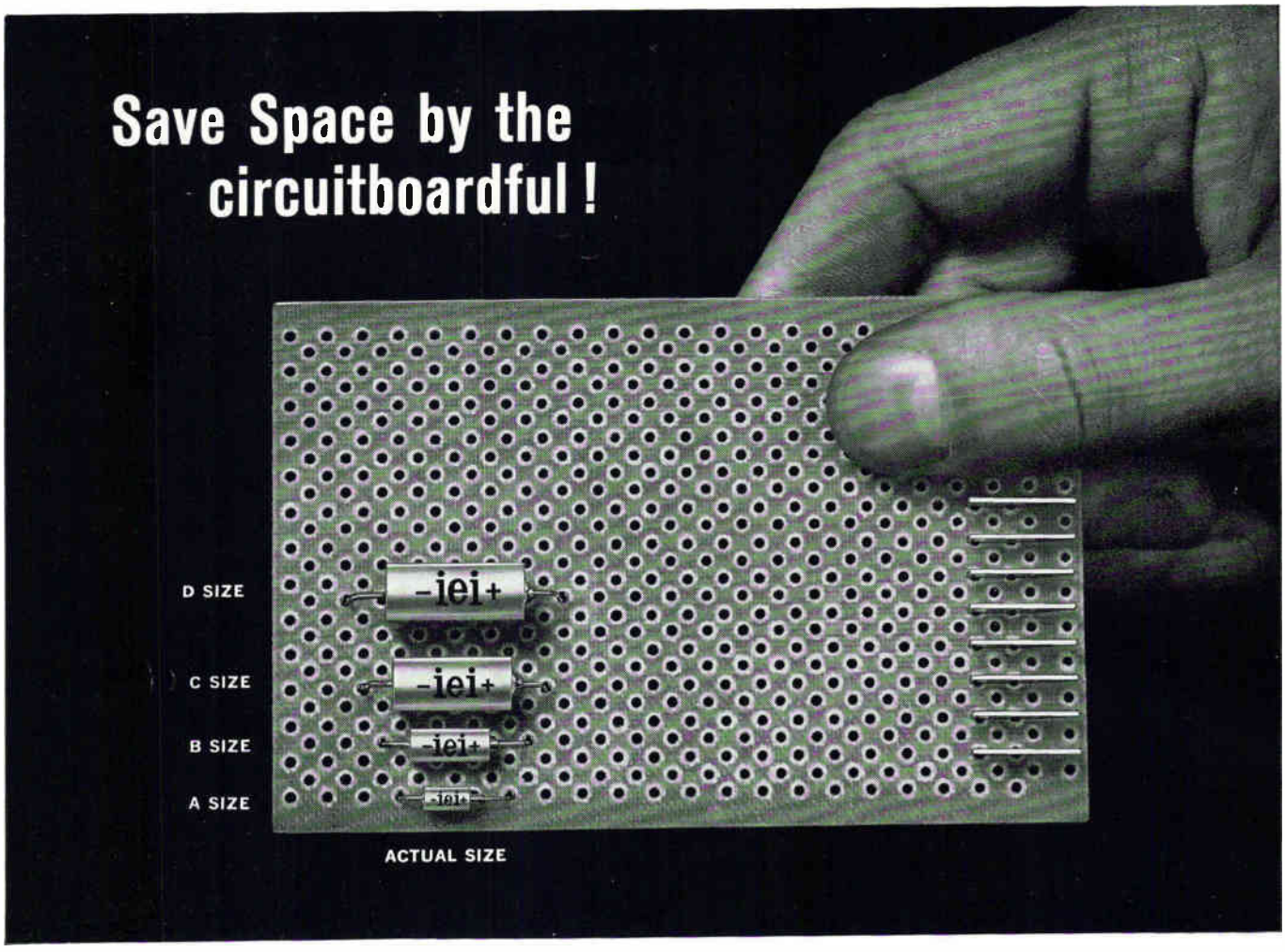

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These widgits are midgets because they have the highest capacitance-voltage product per volume unit of any type capacitor. And their one-piece, sintered core makes them inherently rugged and reliable.

STANDARD CASE SIZE	HIGHEST CE VALUE	TYPICAL RATING
D	2000	100mfd, 20WVDC
C	1200	120mfd, 10WVDC
B	390	39mfd, 10WVDC
A	49.5	3.3mfd, 15WVDC

iei Solid Tantalum "dry slug" capacitors equal or exceed all requirements of MIL-C-26655. They are completely dry and inorganic.

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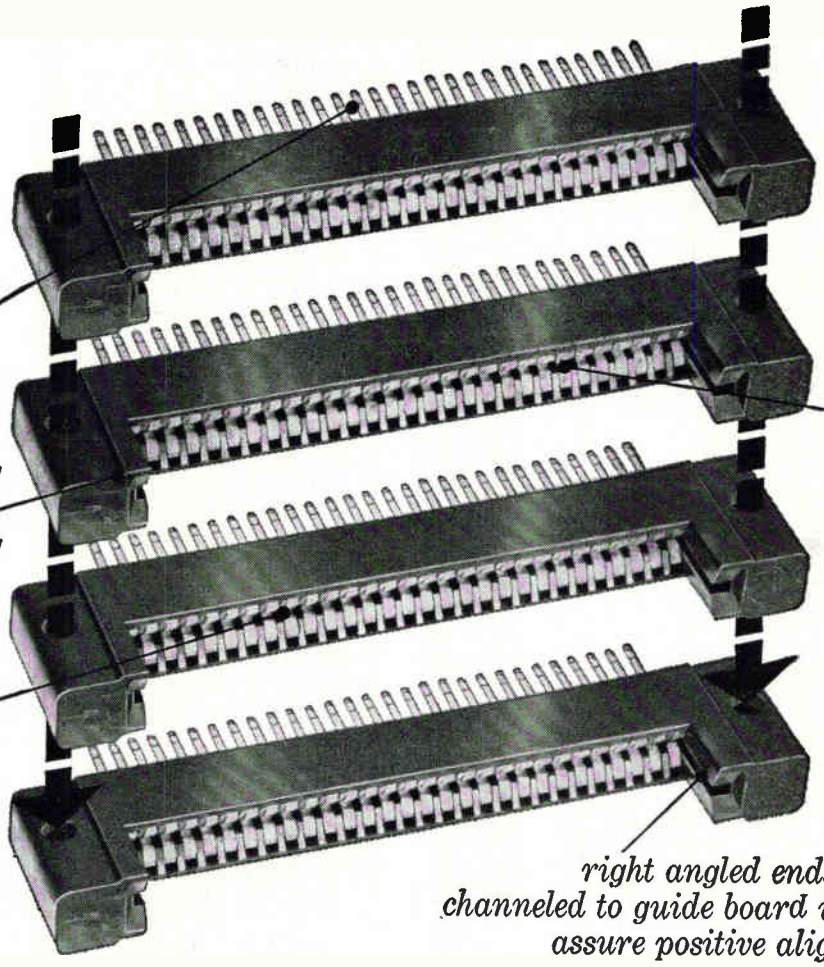
NEW PC CONNECTOR



29 dual contacts on 0.100" centers

gold plated phosphor bronze contacts for 1/16" PC boards

interlocking body design for close tolerance stacking

low insertion force; only .21" insertion depth

right angled ends are channeled to guide board into receptacle, assure positive alignment

FOR HIGH DENSITY CIRCUITS

Model 600-121-29X connectors pictured here are Continental's answer to tough problems of high density printed circuit packaging. Designed for 1/16" PC board, they provide 29 dual contacts on .100 center-to-center spacing. And—their interlocking body design permits connectors to be stacked in any reasonable quantity, with less than .02" cumulative width tolerance in a stack of ten. The unique right angled ends are channeled to guide the circuit board into the receptacle, assure positive alignment and contact with minimum board insertion depth. Solder lug terminations accept #24 AWG wire.

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If you're designing for high density packaging you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: **Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York, or call TW 9-4422.**

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CONTINENTAL CONNECTORS

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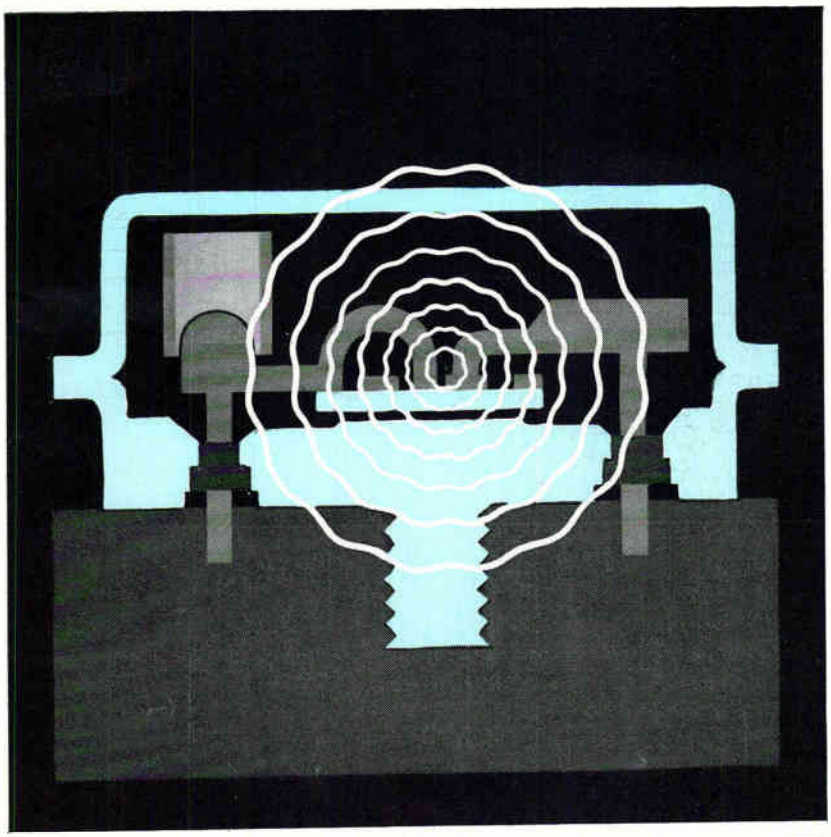
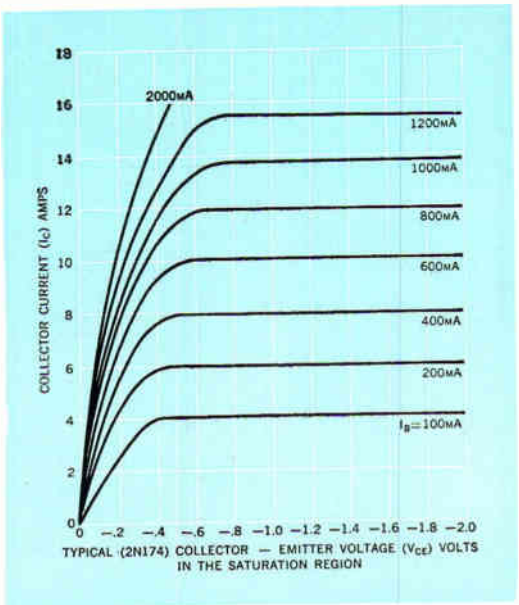




Saturation voltage V_{CE} (sat) is an extremely important transistor characteristic. When the collector to base voltage of a transistor is either zero or in the forward direction and the emitter to base voltage also is in the forward direction the transistor is said to be in saturation. Low saturation voltage improves circuit efficiency and reduces transistor dissipation in applications in which the transistor is driven into saturation. This results in lower junction temperature and improved temperature stability.

TUNG-SOL MINIMIZES V_{CE} (sat)

TO PRODUCE POWER TRANSISTORS THAT DELIVER FULL POWER

Power transistors can be rated by at least a score of characteristics. For most of these, the ratings of an ordinary transistor may be equivalent to the ratings of a Tung-Sol transistor—under *optimum* conditions.

But Tung-Sol engineers have long recognized that power transistors are rarely operated under the so-called optimum conditions. Circuit requirements vary widely and so do operating environments. A better measure of power transistor quality and capability are the characteristics which contribute to transistor reliability and performance under less-than-optimum conditions.

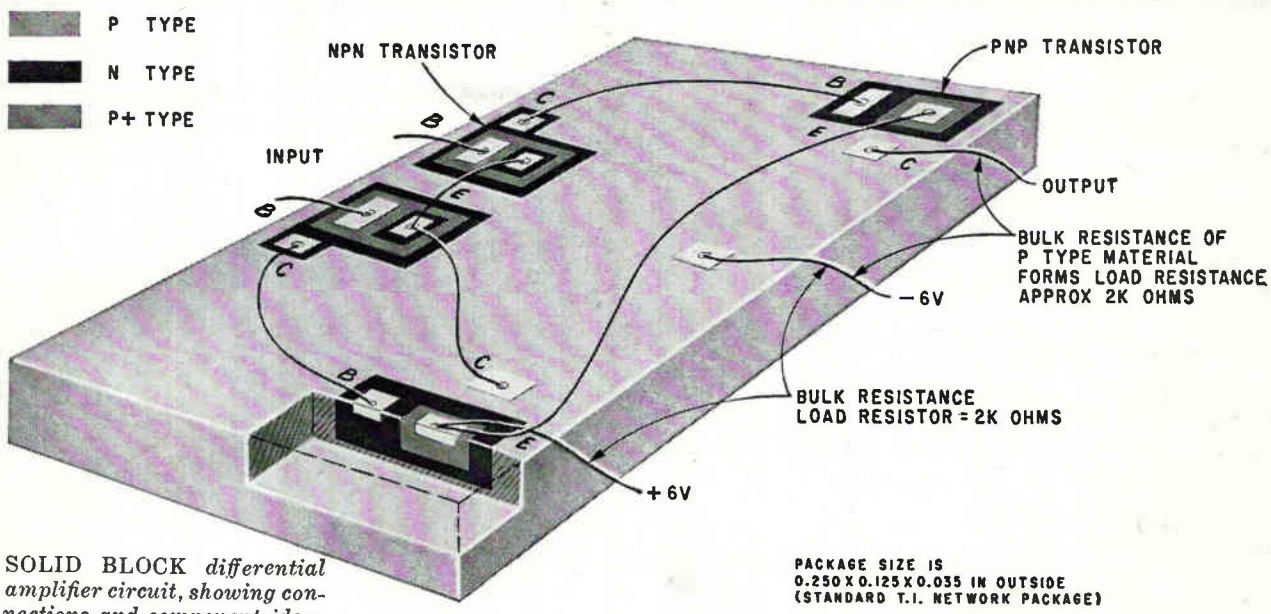
One such characteristic is saturation voltage. Tung-Sol transistors are designed with the lowest possible saturation voltage consistent with other performance requirements.

Low saturation voltage results in lower transistor dissipation and lower junction temperature. This reduces the variation of the temperature dependent parameters of the transistor with resultant improvement in circuit and operational stability. Low saturation voltage decreases internal resistance and temperature and increases useful power-handling. Therefore, a low saturation voltage becomes increasingly important as the transistor is operated closer to its maximum power or in a high-temperature environment.

Low saturation design is typical of the care taken by Tung-Sol to provide the industry with transistors that reliably deliver full power. Ratings, based on stringent environmental and electrical tests, are given for junction temperatures of 110°C. Thermal resistance is low, while breakdown voltages are high.

Two more power pluses are Cold-Welded copper cases, for better heat dissipation and prevention of contamination, and flat-ground mounting surfaces, for full contact with heat sinks. Talk to Tung-Sol about your transistor problems. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193.

TUNG-SOL® FULL POWER
POWER TRANSISTORS



SOLID BLOCK *differential amplifier circuit, showing connections and component identification*

FIRST DETAILS

Differential Amplifier Grown in Silicon Block

Push to analyze circuit functions for translation into silicon block equivalents leads to simple block version of general-purpose differential amplifier. Device fulfills many needs in navigation, fire-control and computer circuits

By W. F. DeBOICE
Senior Technical Specialist,
Autonetics Division,
North American Aviation, Inc.,
Downey, Calif.

J. F. BOWKER
Research Engineer,
Electronics Research Laboratory,
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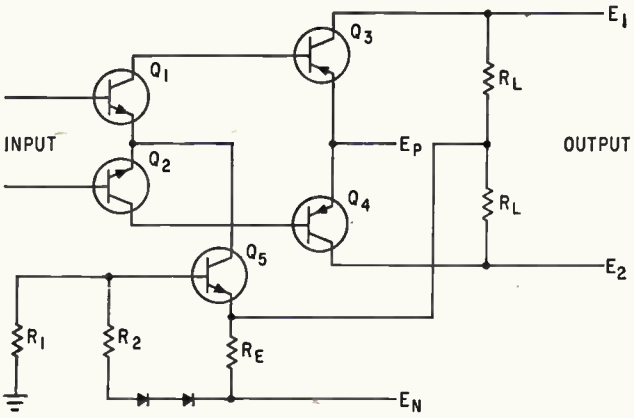
A CONCERTED EFFORT to put molecular electronic techniques to use in inertial navigation, armament and flight control systems led to an examination of system requirements for small-signal linear amplifiers. In high-gain audio-frequency amplifiers, large reactive elements were being used in bypass and coupling circuits to reduce d-c gain to a point that bias uncertainties would not result in d-c saturation of the amplifier. Counterparts for these large reactive elements did not exist in molecular form. It appeared, however, that this problem might be avoided if an amplifier circuit having sufficiently low bias uncertainty could be developed. Such a circuit would also be useful as a d-c amplifier. Thus development of a direct-coupled general-purpose amplifier that duplicated in molecular form was undertaken.

Techniques of molecular electronics lend themselves to the fabrication of well matched pairs of elements. A differential amplifier was chosen to exploit this capability. For simplicity in application of the



GENERAL PURPOSE *amplifier. Circuit design, amplifier characteristics, and differential characteristics are analyzed for block production—Fig. 1*

basic amplifier block the nominal quiescent bias potential at both input and output should be zero. The transfer function of the amplifier block should be simple so that feedback circuits of considerable variety can be attached without creating excessive stability problems.

CURRENT CONTROL—The long-tail circuit, in which transistors are biased by an active current source, achieves low common-mode gain, but does not, however, solve the problem of common-mode bias offset. A means of actively controlling the current source was needed to bring the common-mode output voltage to zero. This was achieved feedback to the emitter of the long-tail current-source transistor, Q_5 (Fig. 1).

Neglecting the effect of finite current gain in the transistors and assuming that each of the diode voltages, V_D, and the base emitter voltage of Q_5, V_{BE}, are equal

$$V_D = V_{BE}. \tag{1}$$

Also

$$R_1 = R_2 \tag{2}$$

and

$$R_E = 1/2R_L \tag{3}$$

Defining the common-mode output voltage

$$E_o = \frac{E_1 + E_2}{2} \tag{4}$$

Under these conditions,

$$1/2(E_N - 2V_D) + V_{BE} = 1/2(E_N - E_o) \tag{5}$$

Equation 5 is satisfied when $E_o = 0$ which is desired. This result is independent of values of supply voltages and absolute values of the circuit parameters, and depends on ratios of certain quantities.

The principal effect of finite current gain in the transistors is to introduce an error due to transistor emitter current in R_E. For the transistors in use in the circuit, the maximum common emitter current gain, β is 200 and the minimum is 50. With these ratios for β, the Q_5 emitter current in R_E is approximately 1/2 percent and 2 percent of the bias current in R_E. The error in E_o may be reduced slightly by adjusting R_E to correct the effect at the design center. This is, however, a trivial refinement because the tolerance that can be obtained on the ratios of the resistors is probably no better than one percent.

Although the experience in production of the circuit in molecular form is inadequate to determine the magnitude of reasonable tolerances, results indicate that the resistance and β spreads and the other less significant uncertainties can be held to a combined tolerance of 10 percent, or possibly 5 percent. The common-mode offset voltage due to this tolerance is computed by applying the tolerance to one-half the magnitude of the negative supply voltage, E_N. Hence, for a negative 10-v supply, the common-mode offset may be held to a tolerance of 0.25 to 0.5 volt. An additional common-mode offset-voltage term is due to the unequality of V_D and V_{BE}. The term may be held to a maximum of about 0.1 volt.

ANALYZING GAIN—The circuit's low-frequency gain characteristics are analyzed with the general diode equation

$$I = I_s\left(e\,exp\,\frac{qV}{kT} - 1\right) \tag{6}$$

which may be solved to determine the approximate incremental input resistance of a common-emitter transistor. At typical operating temperature of 300 K, the incremental input resistance (neglecting the small difference between collector and the emitter current) is

$$R_B \cong R_E h_{FE} \cong \frac{kT}{q}\,\frac{h_{FE}}{I_e} \tag{7}$$

at normal temperature:

$$R_B = \frac{0.026}{I_e}\,h_{FE} \tag{8}$$

where I_e is the collector current and h_{FE} is the incremental common emitter current gain.

Assuming that the transistor pairs and the load resistors, R_L, are perfectly matched and that the common-mode voltage is zero, the differential voltage gain may be formulated based on

$\beta \equiv$ d-c current gain of transistor
$h_{FE} \equiv$ small-signal current gain of transistor
$I_C \equiv$ d-c collector current
$I_B \equiv$ d-c base current

Voltage across each of the load resistors is one-half E_N. Thus

$$I_{C3} = I_{C4} = \frac{E_N}{2R_L} \tag{9}$$

And

$$I_{C1} = I_{C2} = \frac{E_N}{2R_L\beta_3} \tag{10}$$

Making use of Eq. 8

$$R_{B1} = R_{B2} = \frac{0.026h_{FE1}2R_L\beta_3}{E_N} \tag{11}$$

The input signal current is related to the input voltage by the input resistance. The differential voltage gain is

$$G_V = h_{FE1}h_{FE3}\,\frac{R_L}{R_{B1}} \tag{12}$$

Substituting Eq. 11 and reducing

$$G_V = \frac{E_N h_{FE3}}{0.052\beta_3} \tag{13}$$

In typical transistors, h_{FE} is nearly equal to β and

so the parameters may be dropped out of eq. 13. The resulting conclusion that the voltage gain is independent of circuit constants is found to be valid to within 10 percent.

In the derivation of R_B (Eq. 7), I_S is negligible compared to I_C. For silicon transistors the error is less than one percent. A more significant source of uncertainty in the gain stems from the 5 to 10-percent tolerance on the common-mode bias. The linear dependence of R_B on absolute temperature in Eq. 11, is also noted.

This circuit analysis also neglects the effects of internal feedback in the transistors, base ohmic resistance, and collector leakage currents. These effects are, however, trivial in view of the magnitude of the other uncertainties.

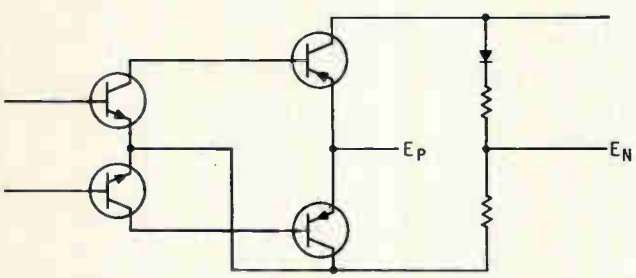
Equation 13 states that the voltage gain of the amplifier is linearly dependent upon the negative supply voltage, E_N. This characteristic is useful in mechanizing automatic gain control, amplitude control and signal multiplication. The amplifier functions with E_N as low as 3 volts, which results in a voltage gain of about 30 db. With a supply voltage of 20 volts, the gain is 50 db.

The collector-base capacitance of the second pair of transistors affords the primary limitation to the amplifier's frequency response. Transistors used in experimental models have resulted in an upper frequency response down 3 db at 50 to 100 Kc. This characteristic may be improved by more optimum design of the transistors in the molecular version of the circuit. Because of the push-pull operation of the circuit, second harmonic distortion is low.

The differential input impedance and the differential output impedances are 2 R_B and 2 R_L. In a differential load, a current flowing out of one of the output terminals is returned to the other output terminal. These two currents add to zero at the junction of the two load resistors, R_L, and so the common-mode control circuit does not sense the presence of the load. If a single-ended load is connected between one of the outputs and ground, however, the common-mode circuit maintains the sum of the currents in the two load resistors, R_L, at the value existing under no load conditions. The action alters the current from the E_P supply (while maintaining constant current from the E_N supply) by changing the currents in Q_3 and Q_4 equally. Analysis shows that the single-ended output impedance is

$$\tfrac{1}{2}R_L$$

The common mode control circuit also augments the common-mode input signal rejection of the amplifier. Analytical determination of common-mode rejection is laborious and involves many transistor parameters that are at present not determined for the molecular version of the circuit. Experimental results show common-mode rejection of 100 db and higher.



SINGLE-ENDED *amplifier, a simple variation of the basic circuit on p 38—Fig. 2*

Data is not sufficient to predict the balance obtained in the transistor pairs and in the load resistors. It is expected that the sum of the mismatch in h_{FE} of the two pairs of transistors, and mismatch of the load resistors, may be specified at 20 percent maximum. The differential voltage offset, therefore, may be specified to a maximum of 10 millivolts. Because many applications will not require particularly close matching, parts will be graded by the manufacturer with respect to matching.

CURRENT-GAIN—Mismatch and load-resistance mismatch are: the sum of the effects operates on the input d-c bias current to produce an input current offset; mismatches unbalance the gain to the two output terminals; and the sum of the unbalance of β_3, β_4 and the load resistors results in a differential input current offset term that operates on the incremental input resistance, R_B, to produce an offset voltage that adds to the unbalance in the V_{BE} of the two input transistors to determine the effective differential-voltage offset.

If the single-ended output of the amplifier is used, the common-mode offset adds to the differential offset. The typical common-mode offset of 0.5 volt and voltage gain of 40 db, however, results in an offset of only 5 millivolts when referred to the input.

A variation of the basic circuit, suggested by Lee Evans of Texas Instruments is shown in Fig. 2. This circuit has the advantage of simplicity, and a factor-of-two increase in voltage gain over the circuit in Fig. 1 when the single-ended gain is considered with equal bias voltage across the load resistors.

This circuit does not operate the transistors in push-pull, and so second-harmonic distortion is high.

The preliminary model of the operational circuit was formed as shown on p. 37. This device was an embodiment of the circuit shown in Figure 2. Model shows two pnp transistors at the ends of the bar of silicon. The two npn transistors are along the cross axis of the bar. The *p* type bulk material is the resistance element between the two *pnp* collectors with the *p* + pads provided for connection to the *pnp* collectors and to the junction of the two load resistors. Interconnections between the circuit elements were formed in this preliminary model by jumper wires bonded to the contact points on circuit elements.

The authors acknowledge the valuable leadership of T. Mitsutomi of Autonetics in establishing the Molecular Electronics Team (MET), and express appreciation to other members of the group.

Acknowledgment is also given to personnel of the Electronics Research Laboratory of Montana State College for their assistance to J. F. Bowker in carrying out additional work on the circuit.

Personnel of the semiconductor networks department of Texas Instruments and particularly John Kilby, Art Evans and Lee Evans have been most helpful.

Countermeasures Receiver

Frequency-determining section is a discriminator composed of passive elements. The WHIP (Wideband High-Intercept-Probability) receiver consists of a wide bandpass filter, the discriminator and a crt that displays the frequencies of input signals

THIS RECEIVER gives frequency information over a wide spectrum and provides a 100-percent probability of detecting incoming signals. It does this without tuning oscillators or tuning filters, unlike typical frequency-determining receivers. Since its frequency-determining elements are entirely passive, only the video amplifiers and the display require a power supply. The receiver may be packaged in a volume of less than one-tenth cubic foot, exclusive of the display. The weight of the frequency-determining section should be under one pound. Frequency resolution is about 1 or 2 percent. This is comparable to a channeled receiver using 80 filter sections in the S-band.

The receiver consists of a wideband bandpass filter, frequency discriminator (including two matched detectors and display. The display consists of two video amplifiers, crt and low- and high-voltage power supply. The display does not require sweep or synchronization circuits.

Absolute frequency indication is independent of incoming power as long as the law of the video detector does not change. This suggests the use of a broadband limiter ahead of the frequency discriminator if large signal environments are expected. Manually operated r-f attenuators may also be used to examine an occasional large signal.

DISCRIMINATOR — Figure 1 shows the discriminator, which can be used at any frequency at which a *TEM* mode can be maintained. Although the schematic is shown in two-wire lines, coaxial, or other line configurations, may be used. The table defines the circuit parameters.

If the line lengths comprising the short circuit and the open circuit are identical, and of the same characteristic impedance (sections L_1 to L_4 (see Table on p 43) have the same Z_o) and are terminated in a resistance R_o equal to the Z_o of the lines, then the ratio of V_{1out} to V_{2out} will uniquely define a frequency if that frequency has been fed into the r-f input. The frequency range over which the uniqueness of frequency is determined is defined by the lengths of the shorted and open line sections.

If n =1 and λ_o is the wavelength of the lowest frequency (f_o) to be determined, then the ratio of V_{1out} to V_{2out} will be unique from f_o to $2f_o$ or an octave. If n is greater than 1, then the frequency range will be smaller. The ratio of V_{1out} to V_{2out} will uniquely describe the frequency from f_o to $2f_o$ if the stub lengths are $\lambda_o/4 = c/4f_o$; also $Z_{in} = Z_o$, independent of frequency.

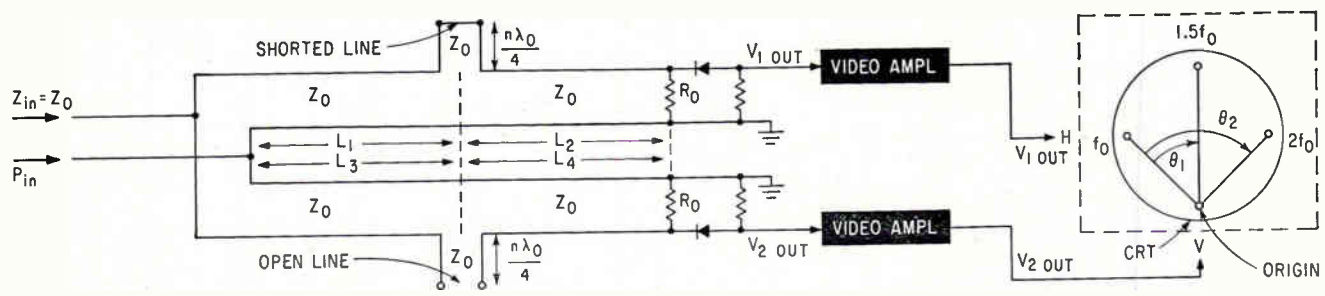
Voltage V_{1out} is fed to the horizontal deflection plates of a crt, and V_{2out} is fed to its vertical deflection plates. Thus, the crt bright spot is deflected from the origin when there is an incoming signal.

If a signal at f_o produces the deflection shown in the inset of Fig. 1, a signal at $2f_o$ will be angularly displaced from the signal at f_o by 90 deg (θ_2 = 90 deg) and all frequencies between f_o and $2f_o$ will have angular displacements between 0 and 90 deg, as illustrated by θ_1. Although this is not the only display method, it is simple.

At higher frequencies, where a waveguide is required instead of wire transmission line, it is not feasible to use open-end stubs; a discrimination method is available using shorted stubs only. In this system (Fig. 2A) the incoming r-f power is equally divided by the power splitter and fed through ferrite isolators to shorted stubs. In one arm, the stub is in shunt (narrow-wall stub) with the main line. In the other, the stub is in series (broad-wall stub) with main line.

With this system, as in the coaxial system, if the shorted-stub lengths are $\lambda_o/4$ long, then the ratio of V_1 to V_2 will determine the frequency uniquely over the range from f_o to $2f_o$. If the length of the shorted stubs is chosen to be $n\,\lambda_o/4$ then the frequency range will be from f_o to less than $2f_o$, depending on the integer n.

Figure 2B shows another system of frequency discrimination that



BASIC CONFIGURATION *of WHIP receiver discriminator. Inset shows frequency display appearing on crt—Fig. 1*

Tunes With Passive Elements

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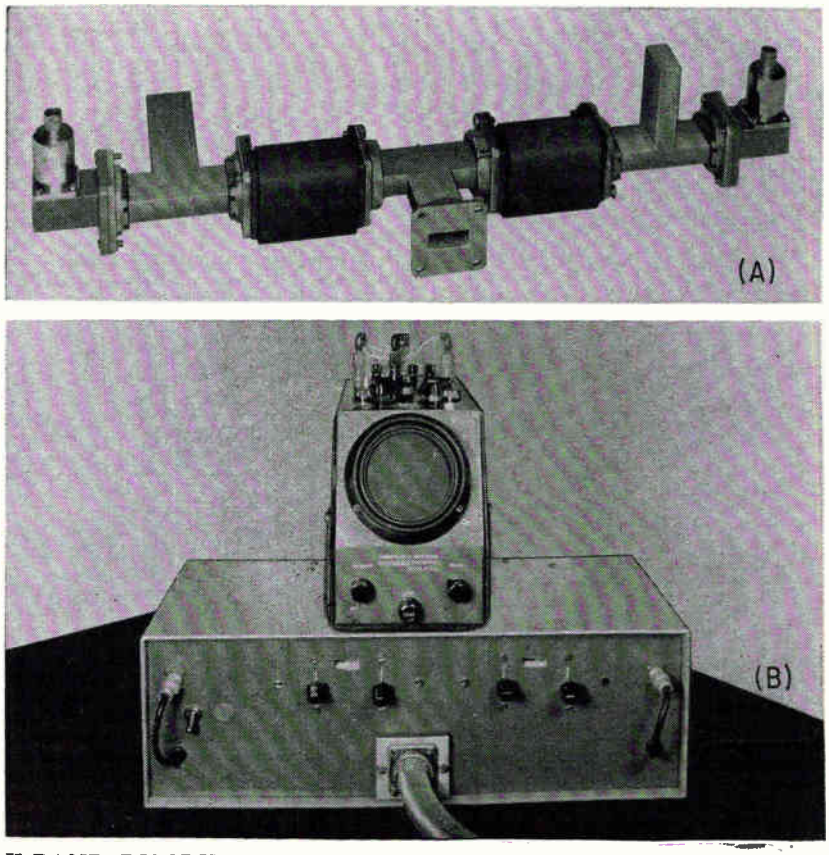
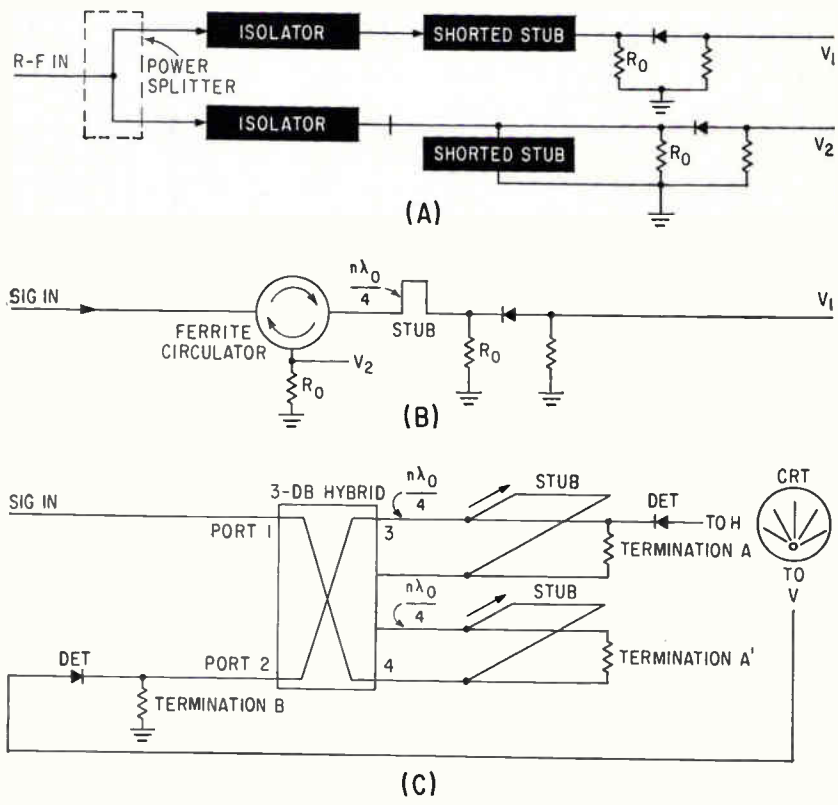
uses only one shorted stub line. This system also provides a unique relationship between the ratio of V_1 and V_2 and the incoming frequency over an octave or less, depending on stub length. Although the stub is shown in series with the load, it may be also in shunt.

Figure 2C shows a frequency discriminator that uses two shorted stubs and a broadband hybrid. This is easy to construct and reproduce. Since the stubs are in shunt with the line, when the frequency is such that the stubs are $\lambda/4$ long, all the signals entering the signal input port will be transmitted to terminations *A* and *A'* after being equally divided and shifted in phase by the hybrid. At the frequency where the stubs are $\lambda/2$ long, the stubs appear as short circuits across the output lines and all the signals at output lines 3 and 4 are reflected. Because of the phase-shift characteristics of the hybrid, none of the signal is returned to the input port 1, but all of it is reflected to termination *B* at Port 2. This scheme has been experimentally verified in the 500 to 1,000-Mc range.

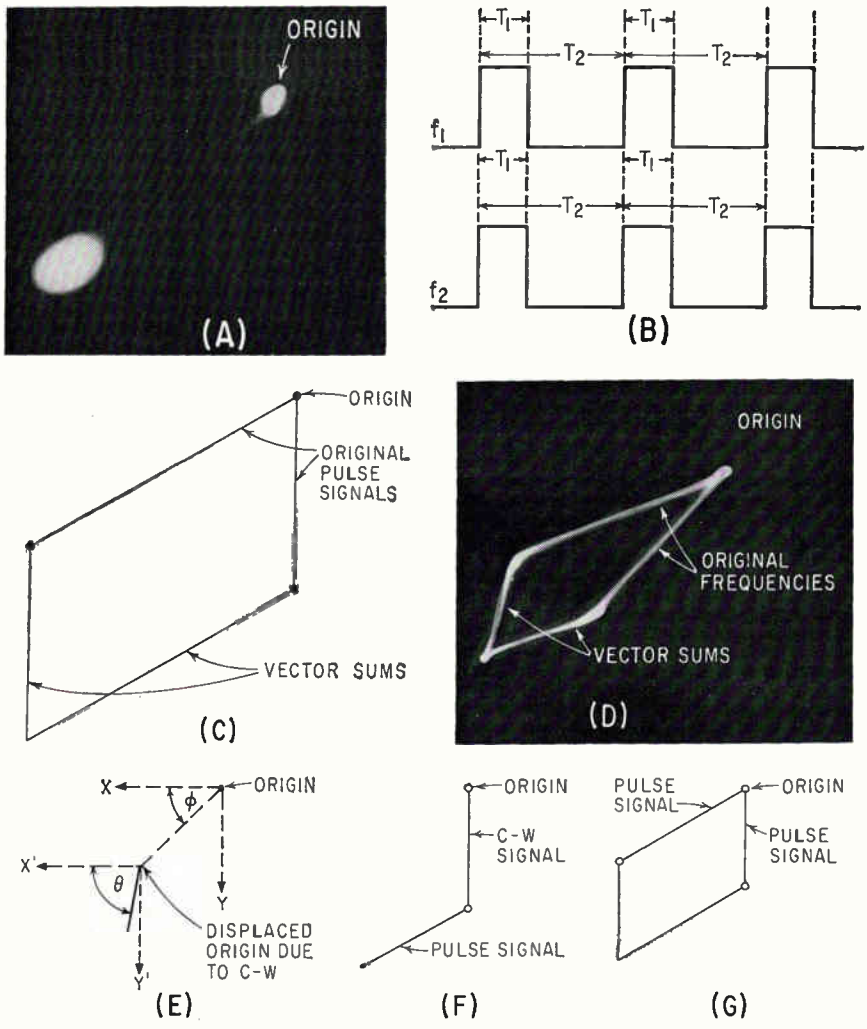
EXPERIMENTAL MODELS—Several models have been built and tested. An X-band unit has been constructed in a waveguide for a feasibility demonstration. This unit operates over the range of 8.5 Gc to 10 Gc with a crt display operating over one quadrant. A uhf model had been built with microstrip and was successful. Additional uhf models as well as S-band models have been built using the hybrid technique and these have worked well. The hybrid technique (Fig. 2C) seems attractive since it is possible to use shunt coaxial elements while series elements are required in some of the other types. This type is, therefore, simple to construct. The frequency-determin-



X-BAND DISCRIMINATOR *(top) is shown in Fig. 2A. Lower photo shows the demonstrator unit and display*



WAVEGUIDE DISCRIMINATOR *of (A) is shown in photo. Discriminator (B) uses circulator, discriminator (C) uses hybrid—Fig. 2*



SMALL SIGNAL PLUS NOISE *(A). Pulses in (B) are coincident in time and pulse width. Traces in (C) and (D) are two partially coincident signals. Displays of (E) and (F) show c-w plus pulse signals; (G) two partially-coincident pulses*—FIG. 3

ing devices using series elements should most easily be constructed in Stripline or Microstrip.

The sensitivity of this receiver is within three db of a crystal video receiver. This sensitivity can be improved by a twt preamplifier in front of the receiver; however, tangential sensitivity with this type of receiver is not useful for frequency determination. The highest attainable working sensitivity of this type of device is about 5 db lower than the normal tangential sensitivity. Frequency resolution improves with improved signal-to-noise ratio (see Fig. 3A).

The crystal detectors used in each of the frequency determining sections of the receiver have been matched pairs of reflectometer crystal and crystal mounts made by Hewlett-Packard. These detectors have been selected for their good r-f match to the transmission line, as this is a prime requirement for accurate operation of the frequency determining elements; in fact, that is a general requirement as well as a limitation to the frequency resolution. Matching is important since mismatches cause frequency errors.

Difficulty has been encountered in increasing the frequency range of the X-band unit above 10.5 Gc. This difficulty can occur when the physical dimensions of the waveguide stubs become comparable to a wavelength at the higher operating frequencies. It may be possible to lower the impedance of the guide to overcome this problem.

SIGNALS—In spite of multiple signal inputs, the receiver provides frequency information for each signal input as long as two or more of the incoming signals are not received in time and pulse-width coincidence. Pulses that are not always coincident in time and pulse width will be correctly displayed. Pulses that are absolutely coincident, as in Fig. 3B, will give an erroneous frequency indication, which in the crt display is the vector sum of the incoming signals; however, in most signal environments, consistently coincident signals are rare.

Incoming signals that are only partially coincident will provide a display of the original frequencies as well as the vector products. The original frequencies are easily discernible from the vector products as shown in Fig. 3C and 3D.

A c-w signal provides a special problem since it is coincident with all other incoming signals. This signal may be handled in several different ways:

(1) Eliminate c-w signals from the display by a-c coupling to the video stages.

(2) Use all d-c coupling to display the c-w component as a displacement of the origin according to the c-w frequency. The pulse-signal display then starts from the new origin, (Fig. 3E). The angle ϕ from the x coordinate to a line drawn through the original origin and displaced origin is equivalent to the frequency of the c-w signal. The pulse signal may now be measured from its new origin or the input to the video amplifiers may be switched to a-c coupling, eliminating the c-w signal.

An operator can recognize signals that are pulses mixed with c-w just as they were recognized in the d-c coupled case. Figures 3F and 3G illustrate this.

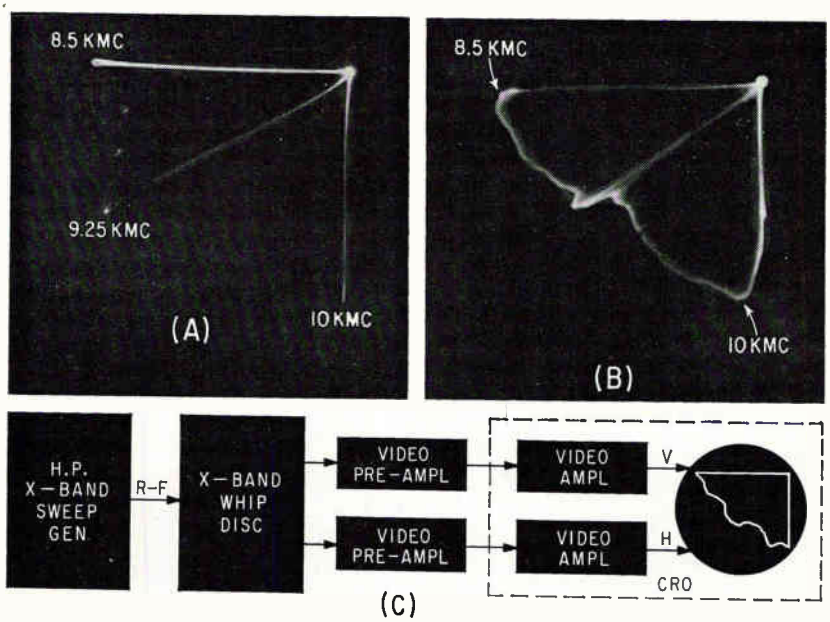
The photographs show the waveguide assembly and X-band feasibility demonstration model. The waveguide circuit is that of Fig. 2A, containing a power divider, ferrite isolators, series and shunt shorted stubs, and a pair of matched crystal mounts. This unit operates over the 8.5-Gc to 10-Gc frequency range, providing an angular frequency display on a modified commercial cro. The tangential sensitivity is −38 dbm with an operating sensitivity of −33 dbm. The feasibility model has two video preamplifiers, plus the cro integral video amplifiers.

The modifications to the cro consist of:

(1) Adding video clamping diodes

DEFINITIONS OF CIRCUIT PARAMETERS

Term	Definition
P_{in}	R-f power input point
Z_o	Line characteristic impedance
R_o	Line termination, resistive ($=Z_o$)
λ_o	Wavelength of lowest frequency to be discriminated
n	Integers 1, 2, 3, 4
$V_{1\,out}$	Detected voltage output of shorted line
$V_{2\,out}$	Detected voltage output of open line
L_1,L_2,L_3,L_4	Length of line
$\frac{n\lambda_o}{4}$	Length of shorted or open line given as integral number of quarter wavelengths at lowest frequency to be discriminated



TRACE IN *(A) shows pulse signals at three frequencies and (B) trace shows swept r-f input; (C) shows test setup*—FIG. 4

to the cro input circuit to provide a fixed d-c reference level independent of input voltage.

(2) Using capacitive feedback in the video channels to provide an integrated output.

(3) Increasing the high voltage to brighten the trace. Oscilloscope displays of this unit are shown in Fig. 4A and 4B. Figure 4C is a block diagram of the test setup. Integration of the pulses in the video amplifier provides a bright line trace, rather than a bright dot at the end of a dim line. The clamping diodes at the scope input allow the use of a-c coupling in the preamplifiers, providing drift-free operation with an overall preamplifier gain above 80 db. The cro video amplifiers are identical d-c coupled channels. The detectors are Hewlett-Packard matched-pair reflectometer diodes having a vswr of less than 1.25. The input vswr of the discriminator is less than 1.25 over 8.2 to 10.2 Gc.

In the future, improved frequency resolution or increased frequency range may be obtained in the following manner: Consider the inherent repetitive nature of the frequency-determining elements. That is, since

$$\tan\theta = \tan\,(n\pi/2)\;(f/f_o)$$

if stubs are cut to a quarter wavelength at f_o, then from $2f_o$ to $3f_o$, the angle θ goes from $\pi/2$ to π and then repeats from $3f_o$ to $4f_o$ to $5f_o$.

It is now necessary only to determine whether the incoming signal is between f_o and $2f_o$ or $2f_o$ and $3f_o$, and to use this information to control the display.

DESIGN PROBLEM—Display frequency in the range 2 to 3 Gc over a 180-degree angle on a crt, using one discriminator.

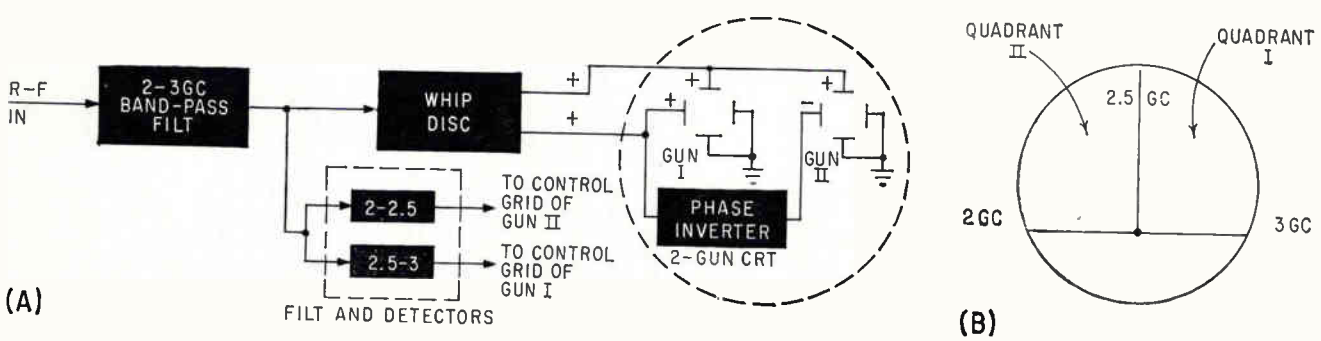
If the stub lengths of the discriminator are cut to correspond to 1 wavelength at 2 Gc, the angle will rotate 90 deg every 500 Mc.

The deflection plates (Fig. 5A) of the two guns are in parallel except for the horizontal deflection plate of gun II, which receives a phase-inverted signal. Then the gun I display is in quadrant I, while the gun II display is in quadrant II (Fig. 5B). To prevent each signal from being displayed simultaneously in both quadrants, part of the incoming r-f signal is fed to a pair of band-pass filters with passbands of 2 to 2.5 Gc and 2.5 to 3 Gc. Pulses from the filters are detected, amplified and fed to the control grids (G_I, G_{II}) of the crt guns, and used to turn on the electron beam, which is normally cut off.

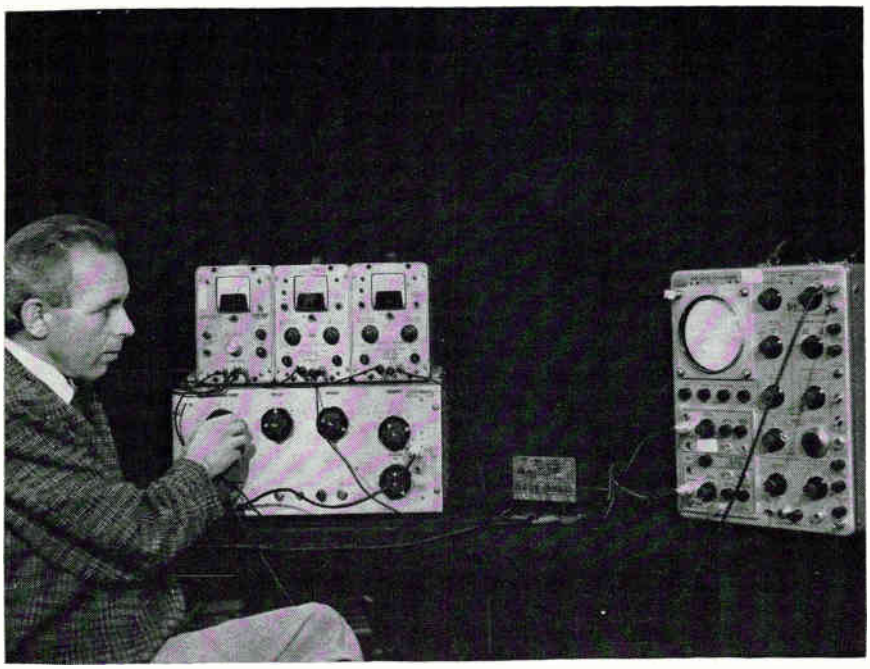
The authors are indebted to H. Hodara (Hallicrafters) and to A. C. Todd (Illinois Inst. of Technology).

BIBLIOGRAPHY

B. B. May, A Wide-Band Frequency Discriminator Using Open and Shorted Stubs, Tech. Report No. 791-2, Stanford Electronics Laboratory, Stanford, Cal.



ARRANGEMENT *(A) for displaying frequency over a 180 deg angle on a crt; (B) shows a typical trace*—FIG. 5



AUTHOR CHECKS *response of level converter*

D-C Level

Transistor level converter has adjustable shift of 0 to 18 volts. Circuit operates up to 32 Mc and has only few nanoseconds delay

By THOMAS MOLLINGA, ElectroData Div., Burroughs Corp., Pasadena, Calif.

IN CIRCUITS it is often necessary to shift a d-c level or signal. This shift should be such that any change in input causes the same change in output. That is, the output signal should be an exact replica of the input signal.

Described here is a high-speed level converter with an adjustable shift of 0 to +18 volts. Delay between input and output is of the order of a few nanoseconds; attenuation is 3 db at 32 Mc.

The circuit has a high input impedance and a low output impedance and is useful for restoring or adjusting the signal level in wideband d-c amplifiers, or for reversing the polarity of the output signal of a square-wave generator.

The basic circuit is shown in Fig. 1A. The emitter impedance of Q_1 includes constant-current generator Q_2. Thus, the current through R_e is constant and any change in input voltage causes the same voltage change at any point along R_e. The signal is coupled into output emitter-follower Q_3 from which the output is taken.

Due to the finite input impedance of Q_3 and the finite output impedance of Q_2, some loss of amplitude will occur. Maximum loss will be at point L.

LOSS REDUCTION—This loss is reduced by connecting a low impedance zener diode (D_z) across R_e as shown in Fig. 1B. Thus, L becomes a low impedance point and maximum loss occurs when R_e is about half value. Maximum loss is now reduced to $\frac{1}{4}$ the original value.

When the frequency of the input signal becomes sufficiently high, the output impedance of constant-current source Q_2 will decrease. The ratio of the impedances between L and N and between K and L will decrease. To keep this ratio high, capacitor C is connected across one section of R_e. The change of charge across C will always be small since the voltage between K and M is practically constant. Capacitor C corrects differences between K and M that may occur during high-speed or transient conditions.

The complete circuit is shown in Fig. 1C. A maximum signal shift of 18 volts in the positive direction can be obtained. The constant current source supplies a current of about 7.3 ma. The 652C5 zener diodes each have a breakdown voltage of 6 v. A current of 3.6 ma flows through R_e, leaving 3.7 ma for the zener diodes. Dynamic impedance of each diode at this current is about 17 ohms.

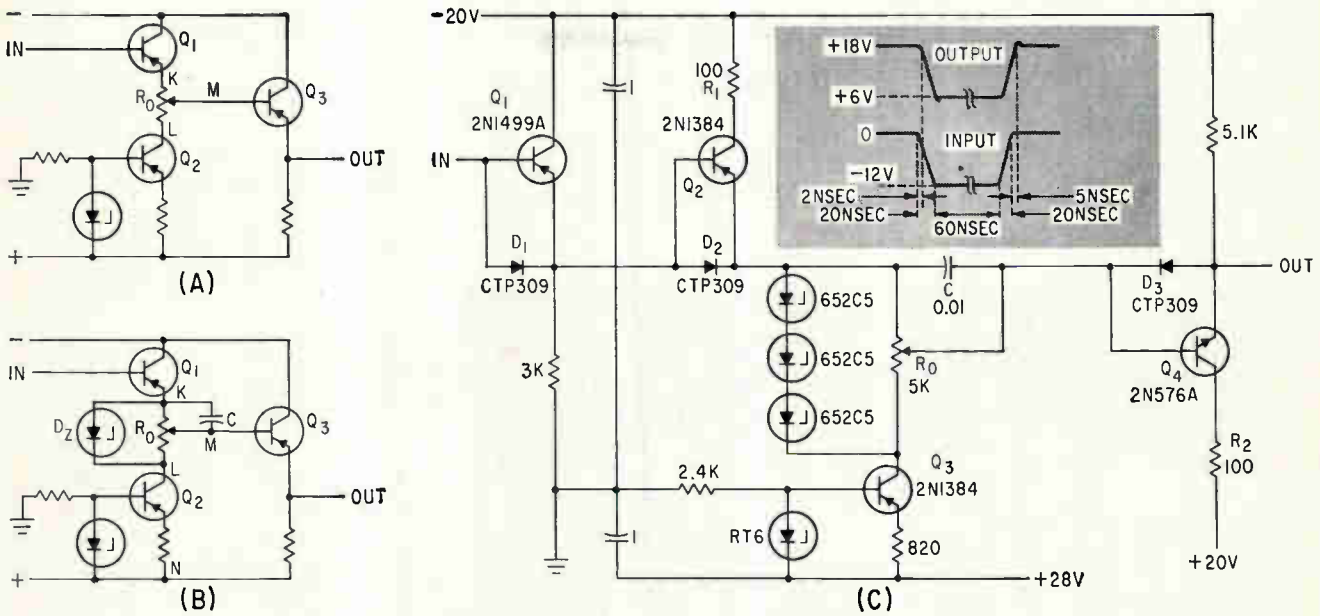
At high frequencies the input impedance of Q_2 decreases due to a decrease in β. To compensate for this, Q_2 is preceded by emitter-follower Q_1. When high-speed signals are applied to the input, Q_1 and Q_2 will be cut off when the signal goes positive due to unavoidable circuit capacitance at the emitters. High-speed diodes D_1 and D_2 discharge the stray capacitance through their low forward impedances.

Output stage Q_4 is an *npn* emitter-follower. Diode D_3 conducts during the fast negative-going edge of a signal. Transistors can be used in place of D_1, D_2 and D_3. Then Q_1, Q_2 and Q_4 would be replaced by complementary emitter-follower stages.

Resistors R_1 and R_2 are for protection purposes and do not affect the characteristics of the circuit.

At low frequencies, the signal source is loaded with a current of approximately $7.3/\beta(Q_1) \times \beta(Q_2)$

Shifter Checks New Computer Modules

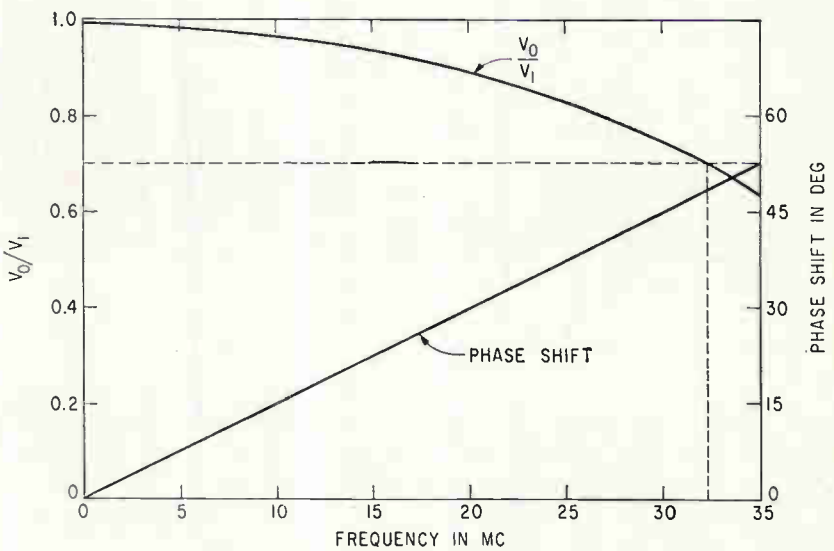


BASIC CONVERTER *(A) is improved in (B) to reduce loss and improve h-f response. Final circuit (C) uses 5-percent tolerance resistors—Fig. 1*

≅ 0.01 ma. When the frequency becomes of the order of 20 Mc this load current will be much larger (1 ma) due to the smaller values of $\beta(Q_1)$ and $\beta(Q_2)$. Therefore, source impedance at these frequencies should be 200 ohms or less.

The high-frequency operation is limited by the output impedance of Q_2 and the collector-to-base capacitances C_{cb} of all transistors. Capacitances $C_{cb}(Q_1)$ and $C_{cb}(Q_2)$ constitute a capacitive load for the source. Effect of this load is small when the source impedance is small, which is practically always the case when high frequencies or high switching speeds are involved. Capacitance $C_{cb}(Q_4)$ is a capacitive load for the output and also $C_{cb}(Q_3)$ when R_o is in its maximum position. When the input signal is a fast pulse, a small overshoot at the output occurs due to these loads.

CIRCUIT RESPONSE— Figure 1C shows response when high-speed square pulses are applied. The input signal is a 12-v negative-going pulse coming from a transistor switch with a collector resistor of 200 ohms. The output signal is delayed from the input signal on the leading and trailing edge by 2 nsec and 5 nsec respectively. Loss in output is less than 2 percent.



Phase-shift and gain characteristics vary with frequency—Fig. 2

Figure 2 shows the response for sine waves. The 3 db-point is at about 32 Mc; here phase shift is slightly over 45 degrees.

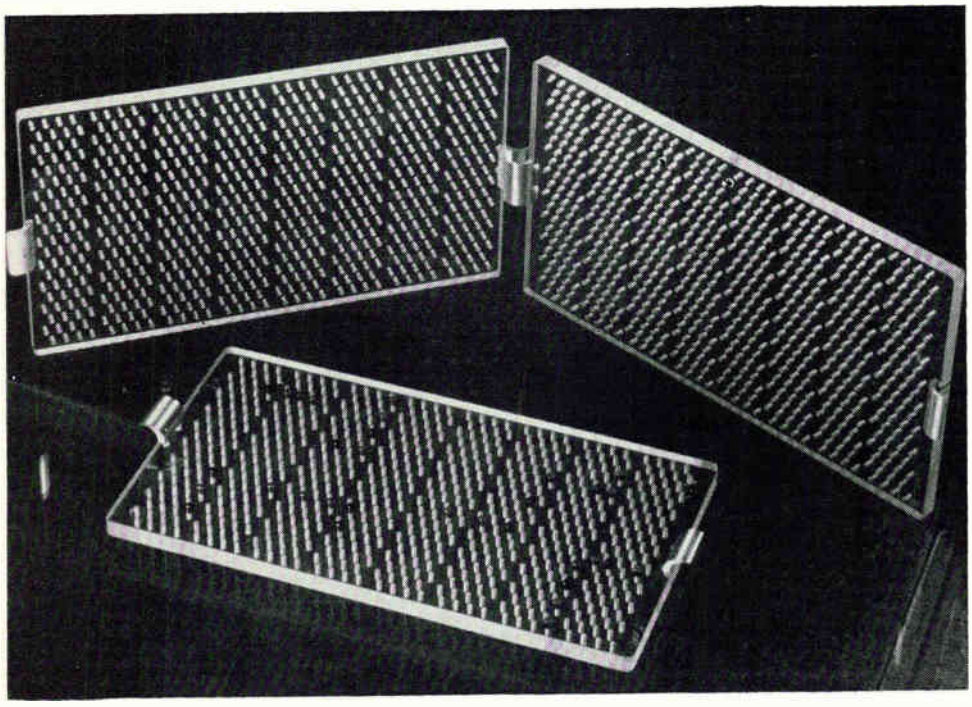
The circuit adds a d-c voltage to a signal without affecting the shape of the signal or delaying it. Smaller maximum shifts than the +18 volts of the circuit of Fig. 1C can be obtained by reducing the zener voltage across R_o. The value of R_o can then be made smaller, along with the current from the constant current source and the supply voltages. Take opposite steps to achieve larger shifts.

The author thanks H. C. Wilck and E. B. Lutz for their assistance.

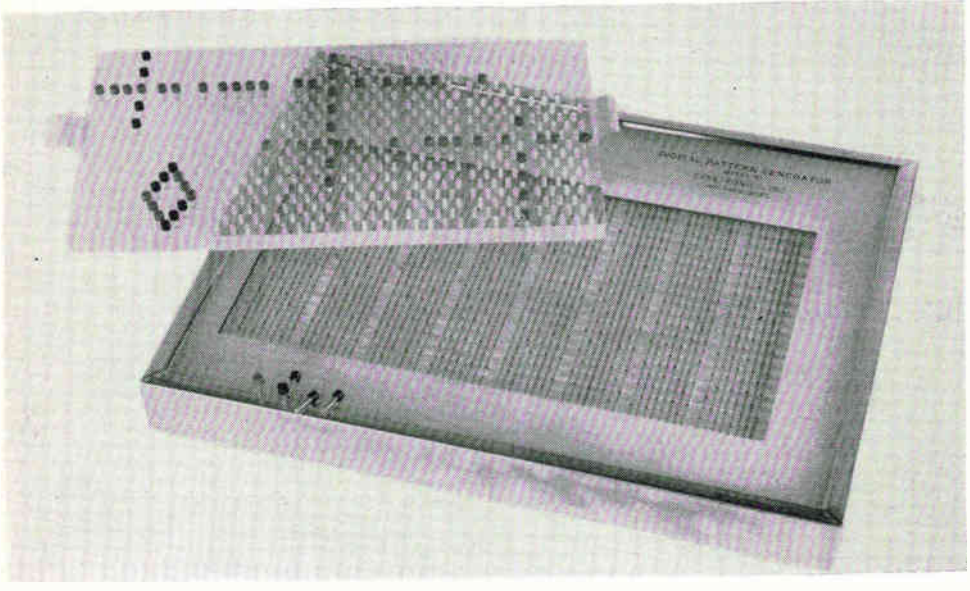
Novel Digital Signal Generator

Miniature permanent magnets are inserted in removable plastic boards to set up a desired program rapidly and economically for digital pattern generation

By WAY DONG WOO, President, Cybetronics, Inc., Waltham, Mass.



DIGITAL PATTERN *generator uses plug-in magnets to set up program*



PLUG-IN BOARDS *can be replaced as particular tests require*

DURING development and testing of digital control devices and large-scale data processing systems, there is often a need for a set of programmed digital signals to simulate commands and responses from one unit to another. The need arises because of interaction among different parts of a system, and interaction of bit patterns as functions of time. In many cases a tester is built for fixed programs. During equipment tests, unforeseen problems requiring new sets of programs of pulses may occur and time is lost in modifying the tester to deliver such pulses.

This digital pattern generator (DPG) allows rapid change-overs from one program to another. The device produces on each of ten output lines a sequence of 64 bits, each of which is determined by the presence of a miniature permanent magnet. No switches are used to set up the program of pulses and the maximum operating speed is 300,000 steps per second.

REQUIRED PROGRAM — Digital pulses are stored in an array of small permanent magnets which are plugged into a pegboard of 64 by 10 holes. Under the pegboard is a 64 by 10 magnetic-core matrix in registration with the pegboard. The core matrix is operated as an 8 by 8 by 10 coincident current magnetic core memory, except that a single reset driver is used in place of digit drivers. The presence of a magnet above a core biases the memory core in a flux pattern as shown in Fig. 1A. Such a biased memory core is unable to switch to a clockwise or counterclockwise flux pattern as shown in Fig. 1B or 1C; therefore, no flux change will result when the core is driven by the X and Y or by the reset winding.

The plug-in magnets are Alnico cylindrical rods having a diameter of 0.125 in. and length of $\frac{1}{2}$ in. The magnetic cores are conventional memory cores with full switching magnetizing force of approximately 400 milliampere-turns. The magnets can be as much as $\frac{1}{8}$ in. away from

Uses Magnetic-Core Pegboard

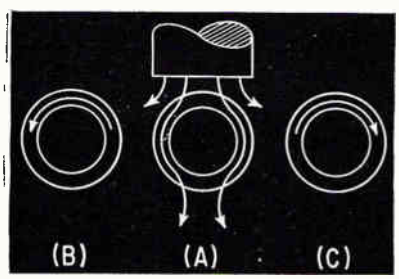
the memory cores and still reliably inhibit core switching. Magnetic field intensity required is estimated to be about ten oersteds.

When a core is not under the influence of the biasing magnet, a voltage results when full switching current is applied. The wave form of the induced voltage is as shown in the first cycle of Fig. 2. When the core is under the influence of the biasing magnet, little voltage is induced, and the wave form is as shown in the second cycle of Fig. 2. This is the basic phenomenon used in this device.

Figure 2 is a timing diagram of the operation of the DPG. The command pulse H_1 causes the DPG to read out a word of 10 parallel bits; P_1 is triggered by the leading edge of H_1 and lasts for 1.5 μs and P_2 is initiated by the trailing edge of P_1 and lasts for 1.5 μs. During P_1, the X driver corresponding to the 3-low order address bits is turned on. The Y driver current is on normally except during P_2. Both X and Y driver currents are approximately 100 ma. Waveform (d) shows the sum of X and Y currents. Reset current I_R, approximately 200 ma, is turned on at P_2 time. At P_1 time, both X and Y driver currents are on, causing a core to switch to the zero state, and a large positive voltage is obtained about 1.5 μs after the rise of P_1. When P_1 goes off and P_2 goes on, the core resets, giving a large negative voltage. The sense winding output is amplified and sampled by strobing pulse g. During the digit cycle after the first H_1, it is assumed that the memory core corresponding to the X-Y address has no magnet above. A positive voltage is induced in the sense winding. It reaches its positive peak about 1.5 μs after X and Y drivers are both on. A strobing pulse, derived from P_1, samples the output of the sense amplifier. The output flip-flop register is caused to go to 0 state if there is a positive voltage during strobe time. In the cycle after the second H_1 pulse, it is assumed that there is a magnet above the core corresponding to the X-Y address. The magnet inhibits switching of this core so that practically no voltage is induced in the sense winding. The absence of a positive voltage at stroke time causes the output flip-flop register to go into zero state.

The logical block diagram is shown in Fig. 3. Selection of a core in the 8 by 8 by 10 coincident current magnetic core memory is done by coincidence driving of X and Y currents. There are eight X and eight Y drivers and a reset driver which threads through all 640 cores. The X drivers are selected by the three lower order bits of the address counter and the eight Y drivers are selected by the three higher order bits of the address counter. An X winding, a Y winding, and a reset winding are threaded through a column of 10 cores. A sense winding is threaded through each row of 64 cores and is connected to a sense amplifier and detector combination. The output of the detector is strobed and the output FF is set or reset according to whether a sense amplifier output signal was present or not.

The six stages of binary counters are driven by the clock circuit which may be triggered from an external source or from an internal variable frequency multivibrator. The counter, in combination with the X and Y driver circuits, energizes an X and a Y winding. One column of the core matrix will have coincidence of X and Y currents, causing the cores in this column to switch to a state of 0. The pattern of windings is such that the fully driven column advances to the right with every advance in the counter. When there is a magnet above the core, no output will be produced in the sense winding, and the output FF will be set to —5 v. When no magnet is above the core, the corresponding output line will be set to ground level.



FLUX PATTERN *in magnetically biased core—Fig. 1*

TIMING—Figure 2 shows the timing of the device. Trigger pulse H for each digit cycle can be triggered externally, or internally from a variable frequency multivibrator. Prior to H, the particular Y driver, as determined by the three high order bits of the address counter, has already been on. Pulse H now turns on the X driver as determined by the three low order bits of the address counter. Where the addressed core is not biased by a magnet, a large pulse will be produced, as shown in the first digit cycle. If there is a magnet above, there will be a small pulse, as shown in the second digit cycle. The sense amplifier output is strobed by a narrow pulse and the output register will assume its final level about 1.5 μs after the initial trigger pulse.

When the strobe pulse is over, X and Y drivers are turned off, and the reset driver is turned on for about 1μs. When that is over, a Y driver is turned on and the generator is ready for the next cycle.

The 640 cores are arranged in 10 rows of 64 cores, with the rows zigzagged to achieve compactness. The dimension of the core matrix plane is 8 $\times$ 14 inches. The first X winding passes through columns 1, 9, 17, 25, and so forth. The first Y windings pass through columns 1, 2, 3, 4, 5, 6, 7, 8, and the second Y windings pass through columns 9, 10, 11, 12, 13, 14, 15, 16, and so forth. The reset windings pass through all the cores. Each winding threads through a core twice to conserve driving current. Each sense winding threads through a row of the offset matrix twice to obtain a high output.

The cores rest in the grooves of a matrix board, and are protected by a thin layer of clear vinyl. The pegboard rests above the core matrix. Magnets are prevented from dam-

aging the cores by the sheet vinyl and the edges of the groove of the core matrix board.

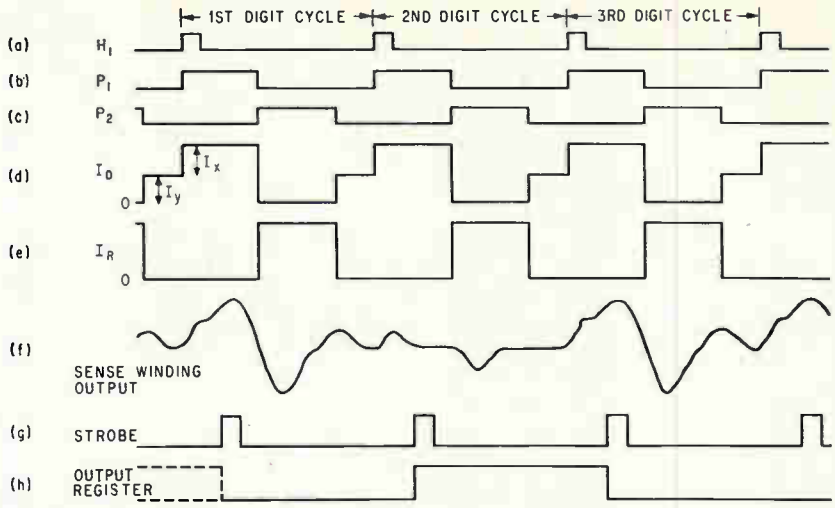
SETTING A PROGRAM — The miniature magnets are inserted into the proper holes in the pegboard. The program can be charged by relocating specific magnets, facilitating alteration of any portion of a program without having to start from the beginning.

For specific programs the miniature magnets can be easily arranged with prepunched perforated cards as overlays on the pegboard. The magnets are inserted through the holes in the card. For frequently used programs, it is not necessary to reset the magnets every time. The entire pegboard, with the magnets arranged in the desired pattern, can be removed and stored for later applications. Another pegboard can be placed in position in a few seconds and the unit is ready for generation of the new program of pulses.

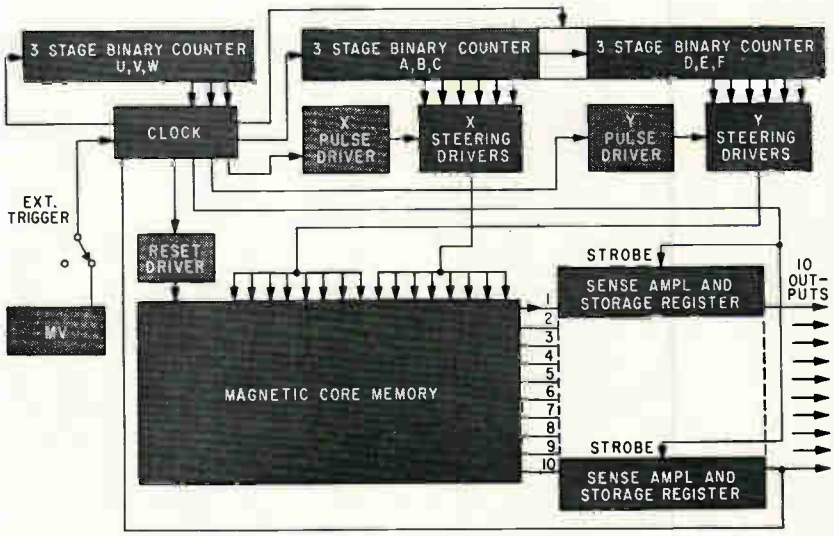
The *X* and *Y* current driving circuits are shown in Fig. 4A. Each driver consists of a pulse driver and eight steering drivers. The pulse driver causes a current of fast rise and fall time to flow through whichever steering driver that has been activated by the outputs of the address counter. The current pulses are nominally 100 ma for the *X* and *Y* driver, and 225 ma for the reset drivers. Since there are two turns in each driver winding, the half select magnetizing force is 200 ma-t and the reset magnetizing force is 450 ma-t.

Figure 4B shows the schematic diagram of the sense amplifier. The input to the sense amplifier is nominally 100 mv. It is amplified and clipped before it is gated with the strobing pulse in the output register flip-flop.

In the repeat mode of operation, the tenth output lines is used to operate a 3-stage binary counter (*UVW* of Fig. 3) which inhibits the carry from *ABC* counter to *DEF* counter until *UVW* has reached a count of eight. By this arrangement, the three lower order bits will repeat a number of times as specified by the tenth output line, which is internally controlled by the plug-in configuration. The allowable number of repetitions are 1, 2, 3, 4, 8, or indefinitely until the plug-in is changed. One can obtain a much longer sequence of digital pulses than the 64 columns provided.



TIMING *of digital pattern generator—Fig. 2*



LOGICAL BLOCKS *of digital pattern generator—Fig. 3*

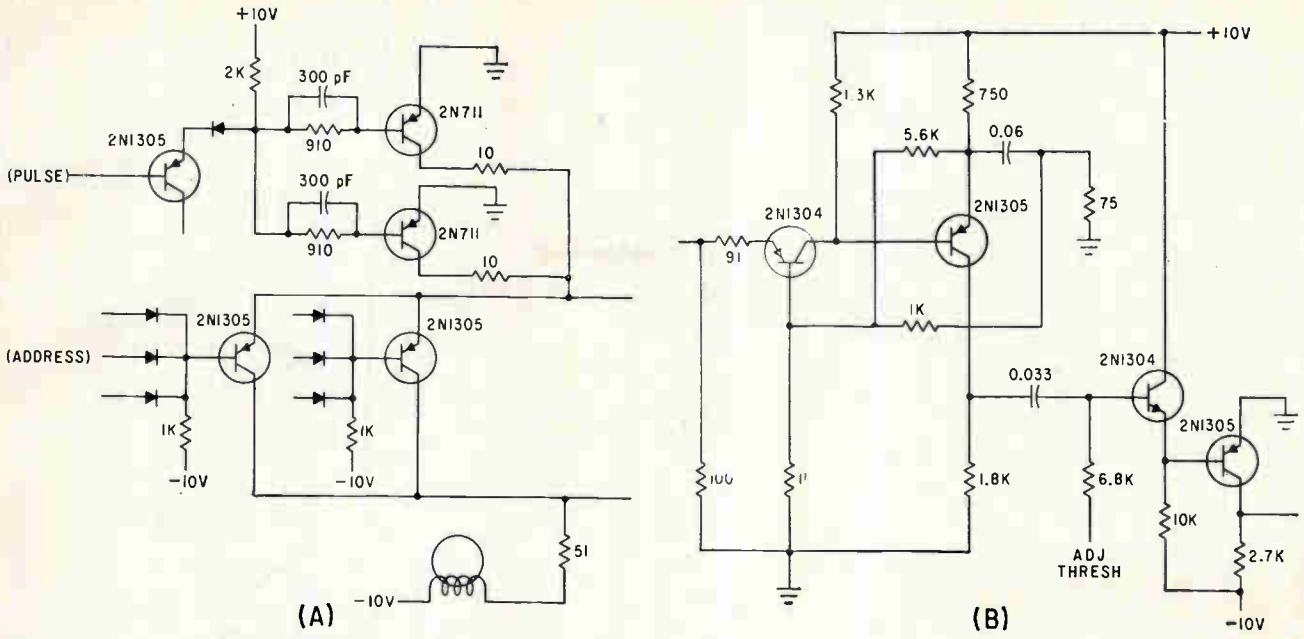
For one shot, single-frame operation, a single frame is read out when the start button is pushed. The output levels will remain until the start button is pushed again, when the next frame will be read out.

In the one-shot, complete cycle, all sixty-four frames will be read at the rate of the internal multivibrator; readout stops after the last frame. If the board is set for repeat operation, the cycle will include such repetition and stops after the last repetition of the last step.

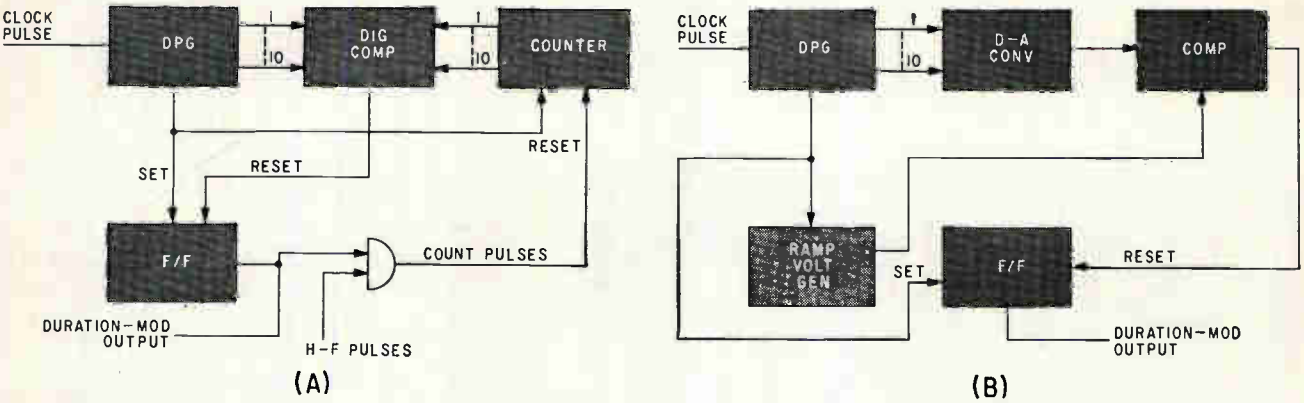
By using one of the output levels, it is possible to stop at any arbitrary frame, and then restart again from the first frame.

DUO-FREQUENCY OPERATION —One of the output lines can be used to control the selection of either internal multivibrator. This will allow two speeds of the programmed pulses.

The DPG can also be operated as a storage device for constant data. By sending a 6-bit address to the *X* and *Y* selection circuits the column of cores as specified by the address will be read out into the output register, where the data will remain until a new address and demand signal is received. The maximum rate of reference is 300,000 times a second. This mode of operation is accomplished by setting the address counter to assume the state prescribed by the input address. In the



CORE DRIVER *(A) and core sense amplifier (B)—Fig. 4*



GENERATING *arbitrary-duration modulation pulses (A); alternate, but not as accurate, system (B)—Fig. 5*

absence of an input address, the counter operates in the normal manner; that is, advancing one count after every read out.

The DPG can be used to generate signals for writing arbitrary information onto magnetic tape, and to simulate the decoded data pulses from a magnetic tape.

By operating the DPG as a storage device for constant data, any six-bit code can be translated into any arbitrary 6, 7, 8, 9, or 10-bit code. In this mode of operation, the 6 input bits determine which frame of the DPG board is to be read out. Each frame of the pegboard is plugged so that the desired output bit configuration is obtained. For a different conversion rule, a new preplugged board can be put in position in a few seconds, with practically no loss in time of the valuable communication channel.

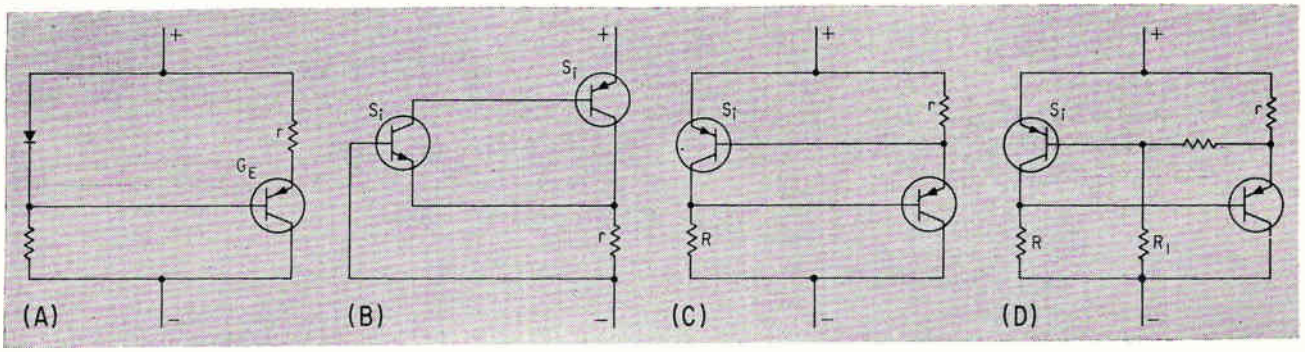
By connecting a conventional 10-bit digital-to-analog converter, one can obtain an analog voltage waveform with the precision of one part in 1,024 and number of sampling points of up to 64. The maximum speed is 300,000 points per second. By making use of the repeat feature of the device, a portion of the waveform can be repeated a number of times so that a much longer wave train is obtained.

Pulses that are arbitrarily duration-modulated can be generated by connecting a DPG to a digital comparator, a counter, and a flip flop, as shown in Fig. 5A. The duration of any pulse is determined by the digital value of the configuration of the plugs of the corresponding frame on the pegboard. Up to 64 pulses, each of arbitrary duration with the precision of 1 part in 1,024 can be generated with the standard 64 by 10 DPG.

Alternatively, the desired signal can be generated by using the system in Fig. 5B. Instead of a digital counter and comparator, a ramp voltage generator and voltage comparator are used. This system is somewhat simpler, but not as accurate.

By using some of the outputs of the DPG to control the amplitude of pulses a combination of duration and amplitude modulation is obtained.

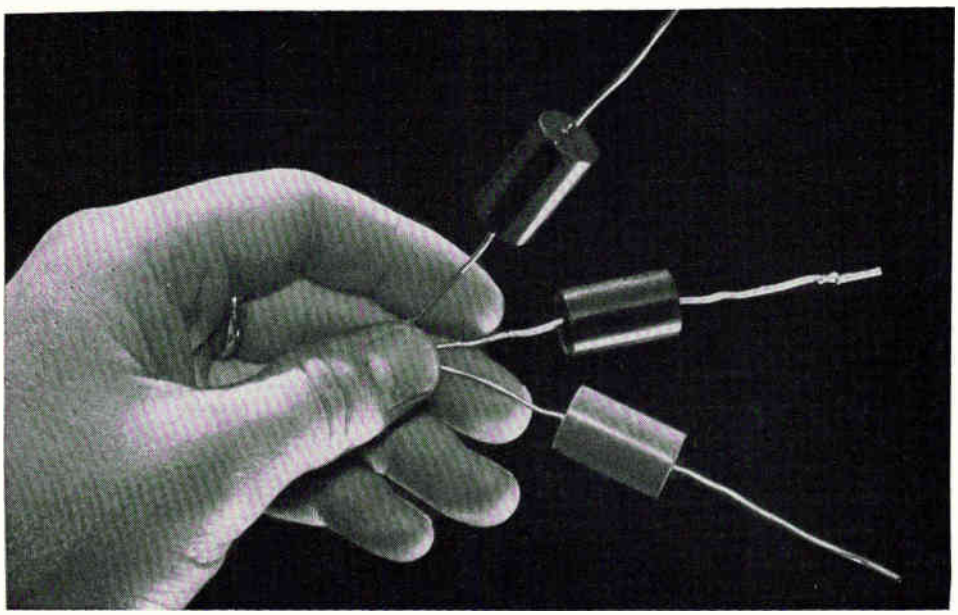
This should prove valuable in determining effects of amplitude variations on the operation of a pulse duration modulation signal.



CIRCUIT OPERATES *over narrow voltage range (A); ideal circuit using complementary transistors is impracticable (B); adaption of ideal circuits uses pnp transistors (C) and improved version has cancellation components added (D) —Fig. 1*

Two Transistors Equal One

Performance of the two-terminal device is analogous to a zener diode except it anchors current not voltage; provides constant current over 5 to 25-volt range



TWO-TERMINAL *units contain pair of transistors wired to give constant-current characteristics over 5:1 voltage range*

THIS SIMPLE, INEXPENSIVE circuit has only two external connections and yields a constant-current characteristic over a range from 5 to 25 volts. It may be used in applications requiring a constant-current drive that cannot be obtained by a resistor. The device may be considered as a circuit element, and as an alternative to the constant-current diode[1], which although developed, has not as yet appeared on the market.

The circuit is temperature sensitive; however, this is not important for most applications, and there are several methods of reducing this sensitivity.

A useful equivalent to the constant-current diode must be simple and cheap and occupy minimum space. The constant-current-diode equivalent circuit meets these requirements.

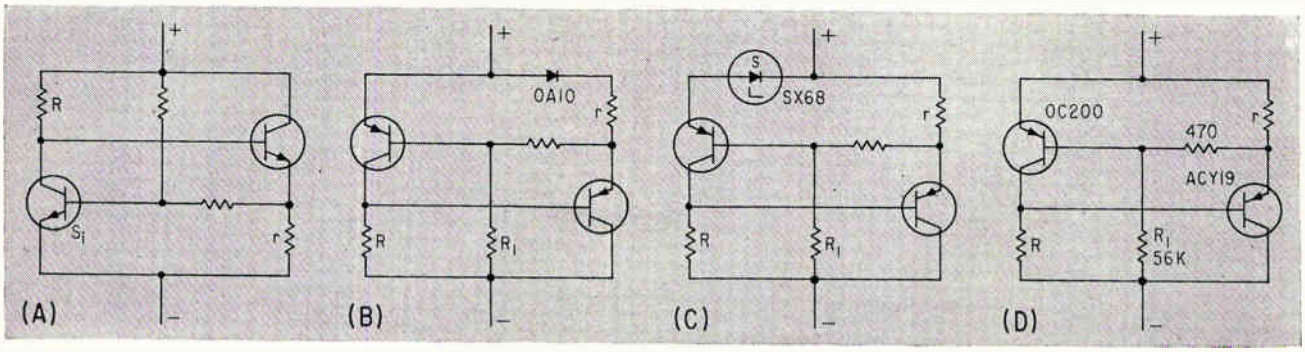
To facilitate the discussion of constant-current devices, it is convenient to define a figure of merit F that relates increments of applied voltage to changes in current.

Such a figure of merit is arbitrarily defined as

$$F = \frac{I}{V} \times \frac{\Delta V}{\Delta I}$$

where V is the applied voltage, I is the standing current at the applied voltage, ΔV is a small change in the standing voltage and ΔI is the change in current produced by ΔV. Thus a perfect constant-current element would have a figure of merit of infinity, while the figure for a resistor would be unity.

A germanium transistor with its base returned to emitter through a resistor is a rough approximation to a constant-current element if the variable voltage is applied between its collector and emitter. The stability of such a circuit with temperature is poor. However, if the base of the transistor is fed from



UNIT WITH NPN TRANSISTORS *is expensive (A); diode is introduced to reduce current variation with temperature (B); zener reduces current variation to 0.005 percent per degree (C). Final circuit (D) has values of r at 470, 220 and 91 ohms for currents 1, 2, and 5 ma, respectively with R at 47,000 ohms up to 2 ma and 33,000 ohms for 5 ma.—Fig. 2*

Constant-Current Diode

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a constant voltage, and an emitter resistor is added, then there is a considerable improvement in current stability with temperature. Practical methods of providing the constant voltage result in a resistance appearing across the element's terminals, Fig. 1A. This sets a limit to the figure of merit F obtainable, and with normal transistors, F would be about seven. No simple method of cancelling the remaining current variation with voltage is possible with this circuit.

The final circuit has an additional stage, in which the V_{be} requirement of a silicon amplifier transistor is compared with the voltage dropped across a resistor inserted in series with the first transistor. The voltage dropped across this resistor is a measure of the first transistor's current. With correct polarity, the circuit forms a negative-feedback loop tending to hold the first transistor's current constant. As this current constitutes almost all of the unit's current, an almost perfect constant-current element would be formed. Fig. 1B shows a complemenetary pair of transistors which would indeed function perfectly if the level of the V_{be} voltage were correct. Fig. 1C is an adaptation of Fig. 1B using all *pnp* types, and here the level of the V_{be} is correct. However, drive current must be supplied to the collector of the amplifier through a resistor R. Therefore, a practical limit to the figure of merit F is found. Cancellation of the remaining current variation is now possible as there is a phase-inverting stage. This cancellation is effected by a series resistance in the base circuit of the amplifier. A current that varies with applied voltage is now provided by R_1. It is possible to achieve a figure of merit of infinity at any spot voltage, although this will not hold exactly for other voltages.

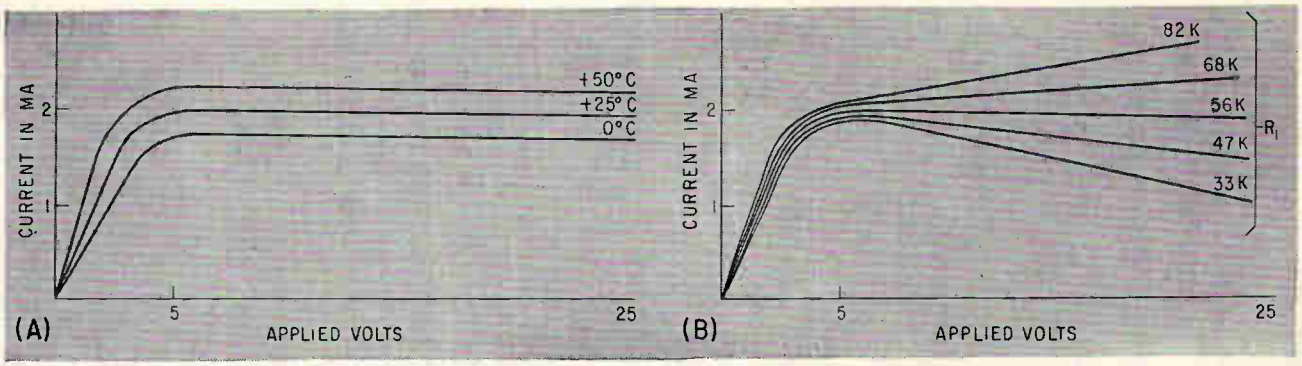
A figure of merit that never falls below fifty over a wide range of voltages is attainable. The complete circuit including the cancellation components is shown in Fig. 1D. An all *npn* version of the circuit is shown in Fig. 2A although this is less useful, owing to the relatively high cost of *npn* transistors.

TEMPERATURE EFFECTS—The V_{be} voltage requirement of the amplifier transistor is compared with the voltage dropped across the other transistor's emitter load resistor. To a first order this voltage is a measure of the total current drawn by the unit, so that temperature induced V_{be} variations will show up as variations of current. To minimize the temperature coefficient of current, it is necessary to use a silicon type for the amplifier transistor, as these transistors have a higher ratio of V_{be} drop to V_{be} variation with temperature, than germanium.

With a typical silicon transistor, the V_{be} drop at room temperature in this circuit is about 500 millivolts. This gives a variation of current with temperature of about $-2.5 \times 10^{-3} \times 100/500 \times 10^{-3}$ percent $= -0.5$ percent per degree C.

Such a variation is not considered to be excessive because in most applications a circuit's d-c standing current is chosen arbitrarily, and may usually be allowed to vary slowly within relatively wide limits. Similar current variations are to be expected from a constant-current diode.

If the temperature coefficient of current of about −0.5 percent per degree C is intolerable, it is possible to effect some improvement by including a diode in the amplifier circuit. In Fig. 2B the diode has been included in the emitter circuit of the final transistor. About 0.25 volt will be dropped across an OA10 type of diode, and this voltage will have a negative temperature coefficient opposing the V_{be} voltage variation of the amplifier transistor. This method does not produce complete cancellation of temperature coefficient however. If a much higher minimum operating voltage for the whole unit



VOLTAGE VERSUS CURRENT *characteristic of circuit for 2 ma (A); variation of cancellation resistance R_1 gives positive or negative characteristic (B)—Fig. 3*

can be tolerated, then almost complete cancellation of temperature coefficient is possible by including a zener diode with positive coefficient in series with the amplifier's emitter. A circuit incorporating the SX68 zener is shown in Fig. 2C. By selecting either the amplifier transistor or the SX68 zener diode, it is possible to achieve 0.005 percent per degree C variation of current for a 50 degree C temperature variation. A minimum of 10 volts is necessary for this circuit to operate.

Practical considerations limit the choice of transistor for the amplifier stage to a silicon type, and for extreme cheapness the *pnp* version of the circuit is used. Common emitter gain is not of primary importance, neither is voltage rating, so that the transistor can be chosen on a cost basis only.

IMPROVING PERFORMANCE—If a good figure of merit is to be retained down to low voltages, a high-gain transistor is required in the output stage. The primary advantage of using a high-gain transistor is that the base feed resistance to this stage may be made higher. This means that less cancellation is required, and irregularities in the cancellation at differing voltages have less effect. A silicon type could be used, but it would make the cancellation a little less effective. A practical choice for this stage is the ACY19, since these transistors have a reasonable voltage rating combined with a high gain. They are also cheap.

If this circuit is to replace the constant-current diode, then a range of current ratings is necessary. The basic circuit shown in Fig. 2D is adaptable to a range of current ratings from 1.0 ma to 5.0 ma. For other current ratings a redesign is required, although if a lower figure of merit can be tolerated, the present circuit may be extended both up and down in current. The most popular current ratings would seem to be 1.0 ma, 2.0 ma and 5.0 ma, and the units were designed for these values. The circuit could probably be adapted to include current ratings down to at least 0.1 ma by using planar transistors, which hold their gain figure down to low currents. In the other direction, using high-gain medium-power silicon transistors in the output stage could extend the range of current ratings up to at least 20 ma.

The minimum voltage for satisfactory operation is about five volts. Operation down to three volts is permissible if the lower figure of merit obtained is tolerable. Extra cancellation may be used however, and a good figure of merit over a voltage range from say three to eight volts is then possible. The maximum voltage that the unit will stand is determined by the output transistor alone. For the ACY19 transistor a provisional maximum voltage of 25 v is suggested: this allows a good safety factor, as the ACY19 is rated at 40 v for low collector currents.

Prototype circuits have been constructed as potted cylinders 1.3 cm diameter by 2.6 long. This construction incorporates miniature high-stability resistors and is shown in the illustration.

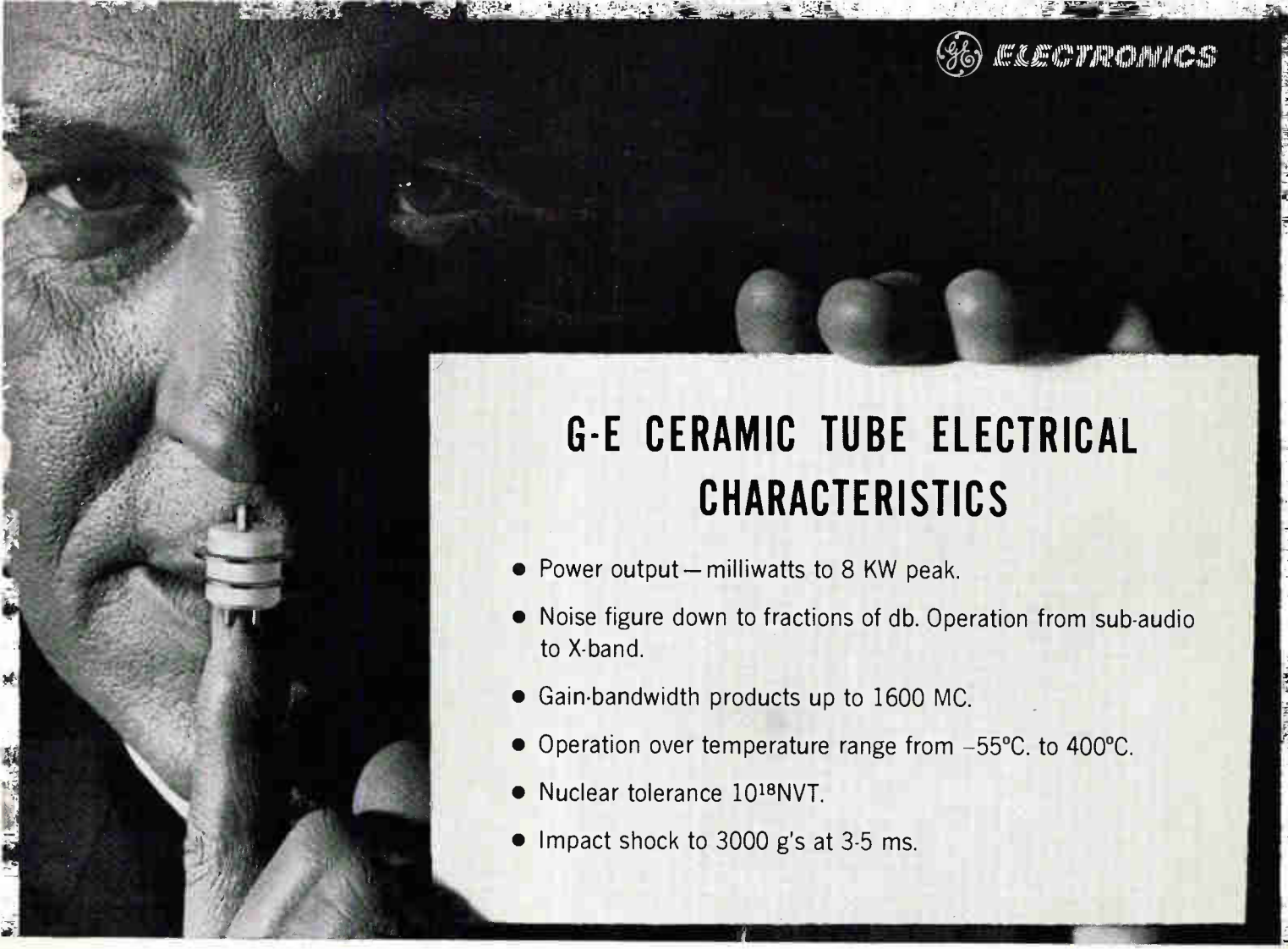
Figure 3A shows a typical voltage versus current characteristic for the 2 ma circuit at various temperatures. This unit has been adjusted to give the flattest response over a voltage range of from 5 to 25 v. A similar curve is obtained for other units. The h-f characteristic is such that the unit appears as a capacitance of about 120 pf in parallel with its d-c impedance. (For an applied d-c potential of 6 volts only; the capacitance is mainly due to Miller effect acting upon the collector-to-base depletion layer capacitance.) There seems to be little requirement for h-f performance in excess of that provided by the unit. If a better h-f performance is required, an h-f type transistor should effect considerable improvement.

The value of current obtained from any unit over the stated voltage range is always within ±25 percent of its nominal value at temperatures from 0 C to +50 C. Operation at temperatures above +50 C is not advised because leakage current in the output transistor becomes excessive and this makes the amplifier draw more current. The cancellation is found to become ineffective under these conditions. If high-temperature operation is specifically required then a high-gain silicon type must be used in the output stage.

Figure 3B shows the effect of varying R_1. It shows that the characteristic can be adjusted to give a range of slopes from positive to negative.

REFERENCE

1) T. K. Hemingway, Applications of the Constant Current Diode, ELECTRONICS, p 60, Oct. 20, 1961.



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New Design Method Optimizes Gain-Bandwidth

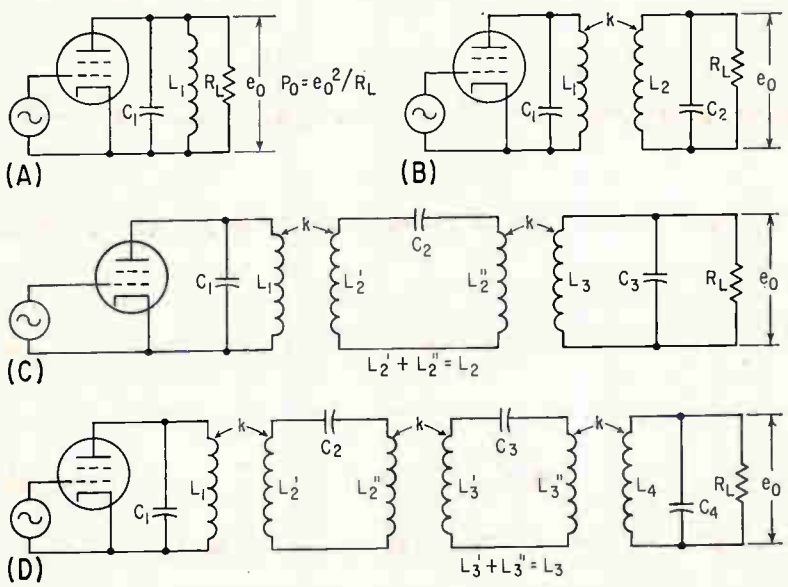
When power gain-bandwidth product is a prime consideration, this method for determining double tuned circuit parameters assures optimized design

By ALLEN I. SINSKY and HARVEY M. MAYROVITZ The Bendix Corp., Baltimore, Md.

POWER GAIN-BANDWIDTH is optimized by proper choice of double-tuned circuit parameters. A method is described here for determining these parameters and also the comparative improvement that a double-tuned circuit provides over a single-tuned circuit.

In designing r-f power amplifiers it is often necessary to couple the output of a tetrode or pentode stage to a resistive load such that the power into the load remains above a specified level over a given frequency band. Maximum attainable power gain-bandwidth product should be realized for each tube type.

For a tetrode or pentode amplifier, when the screen and supressor grids provide good isolation between the input and output circuits, the output current can be considered as proportional to the input voltage only. For a given input voltage (constituting a given input power), the output power, and consequently the power gain (P_{out}/P_{in}), is a function of the plate load impedance. However, owing to the shunt output capacitance of the tube, the power gain is sensitive to frequency; a four-terminal network inserted between the output terminals of an amplifier tube and a frequency insensitive resistive load (R_L) optimizes power gain-bandwidth.



ISOCHRONOUSLY TUNED *coupled circuits: single tuned (A); double tuned (B); triple tuned (C); and quadruple tuned (D)—Fig. 1*

POWER GAIN-BANDWIDTH —Power gain-bandwidth is defined as the product of the mid-band power gain and the bandwidth at some prescribed power level below that at midband. In optimization of this parameter, it should be realized that more complex networks (Fig. 1C and Fig. 1D) have better frequency rejection characteristics than the double tuned circuit, but frequency rejection is not the prime consideration in this analysis.

The power gain-bandwidths of the single, double, triple and quadruple isochronously tuned, transistionally coupled circuits of Fig. 1 were determined assuming an infinite Q for all but the output loops. This is a valid approximation if the Q's of the

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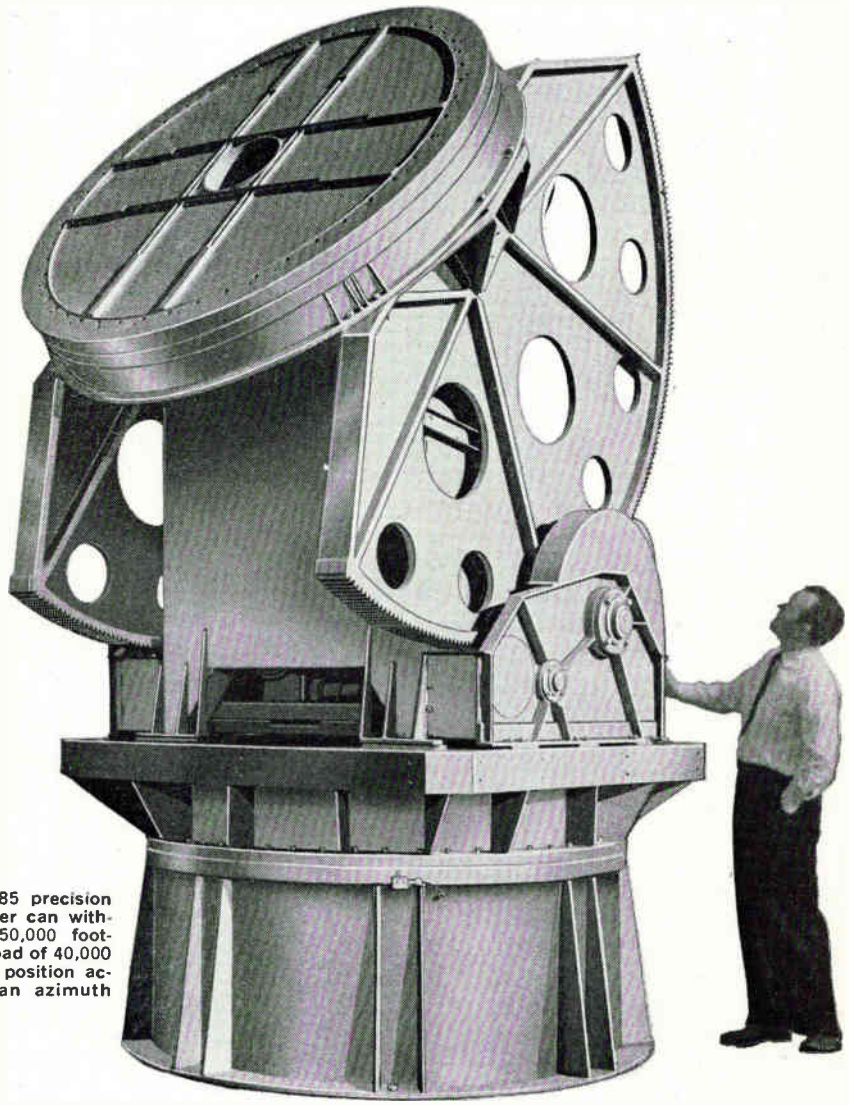

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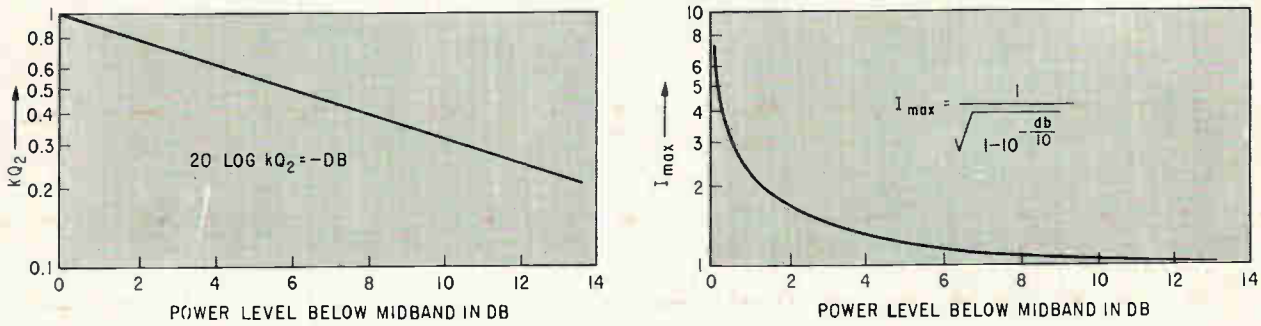

OPTIMUM KQ_2 *(to left) and maximum power gain-bandwidth improvement of double tuned circuit over single tuned circuit (right) for various values of db—Fig. 2*

primary and intermediate loops can be made as large as desired while the loaded Q of the output loop remains small in comparison.

It was found that the improvement in power gain-bandwidth of the transitionally double-tuned circuit was $\sqrt{2}$ times better than that of a single tuned circuit and that the additional improvement with the more complex networks was small and rapidly approaching a finite limit. Considering the additional losses (that is, intermediate Q's not infinite), increased cost, and inherent tuning problems in the more complex networks it becomes evident that the most desirable configuration is the double-tuned circuit.

POWER LEVEL — Frequently, it is the bandwidth at levels other than the half power points that are of interest. It is, therefore, desirable to formulate the conditions necessary to achieve the maximum gain-bandwidth product when the bandwidth is measured to some arbitrary power level below that at center frequency.

The improvement factor (I), which is the improvement in power gain-bandwidth of a double-tuned circuit over a single-tuned circuit, has been derived and is given by:

$$I = [2\,(kQ_2)^2 - 1 + \sqrt{1 - 4\,(kQ_2)^2 + 4\,(kQ_2)^4\,10^{db/10}}\,]^{1/2} / (kQ_2)^2\,\sqrt{2\,(10^{db/10} - 1)} \qquad (1)$$

Where k is the coefficient of coupling, Q_2 is the loaded secondary Q (refer to Fig. 1B), and db is the power in decibels below midband power corresponding to the level at which the improvement is determined. Equation 1 reveals that, for any value of db, the improvement (I) depends only upon the product of kQ_2 rather than upon their individual values.

For a particular value of db there is a value of kQ_2 that maximizes I. This value, found by differentiation, is

$$kQ_2 = 10^{-db/20} \qquad (2)$$

Substituting the value of kQ_2 from eq. 2 back into eq. 1 gives the maximum improvement (I_{max}) of the double-tuned circuit over the single-tuned circuit for a particular value of db. This value of I_{max} is

$$I_{max} = \frac{1}{\sqrt{1 - 10^{-db/10}}} \qquad (3)$$

Equations 2 and 3 are plotted in Fig. 2 so that it is possible to find the maximum attainable improvement over the single tuned circuit as well as the value of kQ_2 to achieve this improvement. The value of k is found to be equal to the percentage bandwidth for maximum power gain bandwidth improvement so that Q_2 and k can be uniquely determined.

An example of the use of this analysis is given in a problem. It is desired to build an r-f tetrode power amplifier stage such that the power output remains greater than 4 db below the center frequency power output 5 Mc either side of the band center. The band center frequency is 100 Mc. Maximum power gain-bandwidth is desired.

The values of k and Q_2 are found and the power gain-bandwidth is determined. Step I: The value of k is equal to the percentage bandwidth, $k = \Delta f/f_o$ = 10Mc/100Mc = 0.1. Step II: The value of kQ_2 corresponding to 4 db is found from Fig. 2 to be 0.63. Step III: Solving for Q_2, knowing k and kQ_2, $Q_2 = 6.3$.

The power gain bandwidth improvement is found from Fig. 2 to be 1.29 times better than that of a single-tuned circuit.

SUMMARY—This analysis provides a method for choosing double-tuned circuit parameters when power gain-bandwidth product is the prime design consideration. The curves of Fig. 2 allow the designer to establish quickly the values of these parameters for his application.

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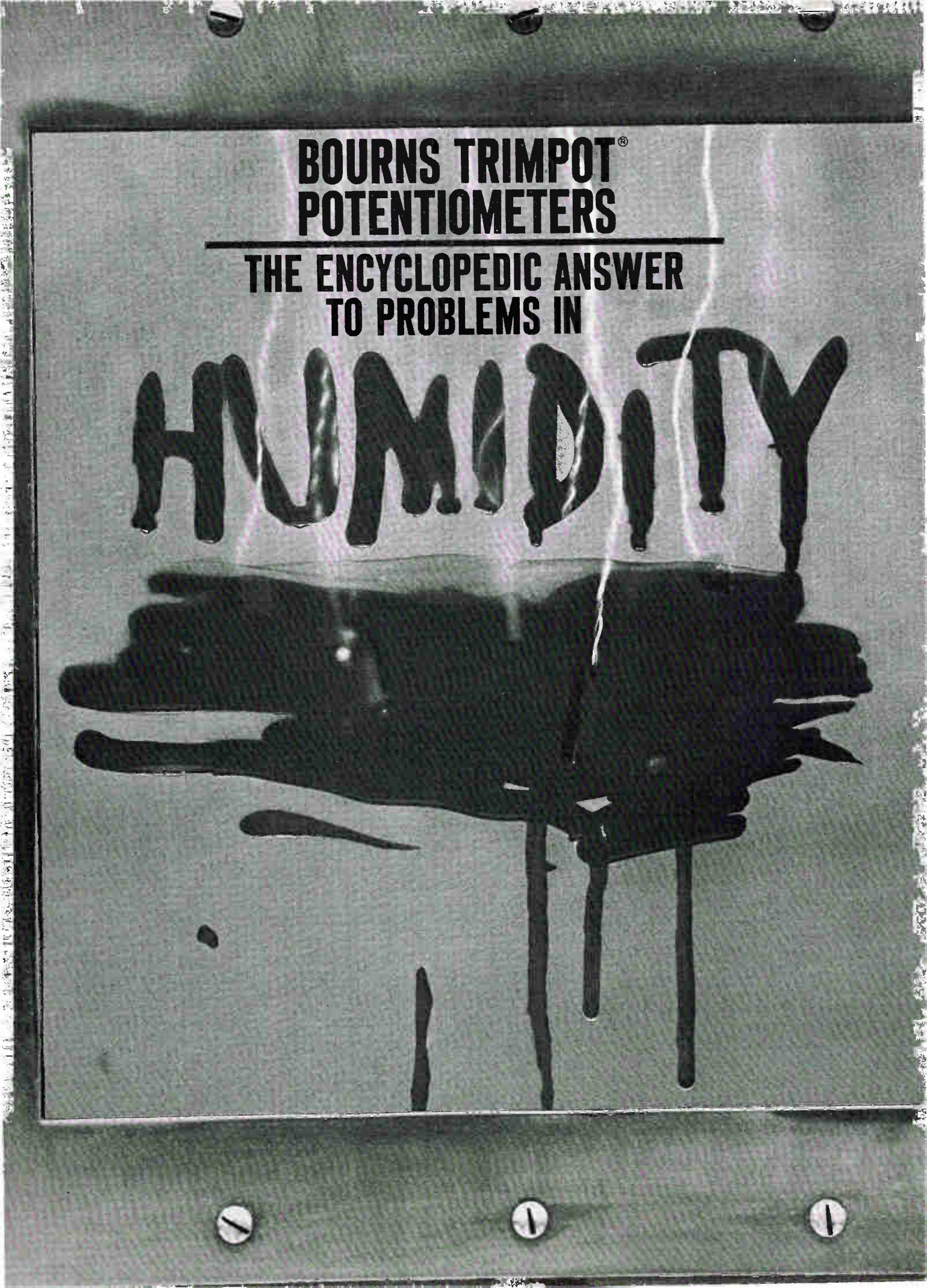

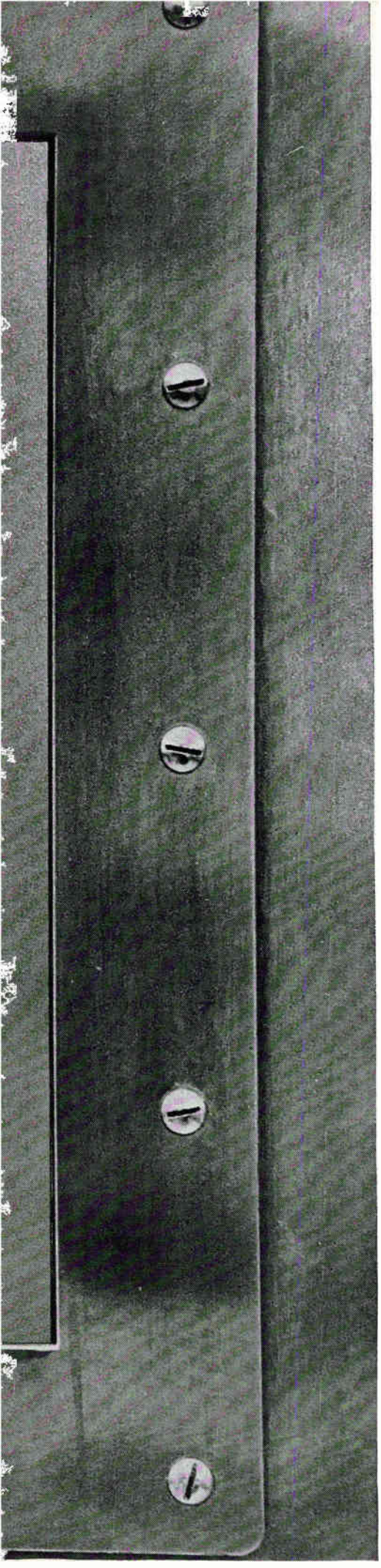

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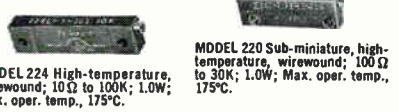
MODEL 3251 Square, high-temperature, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp., 150°C.

MODEL 3010 High-temperature, wirewound; 10Ω to 100K; 1.0W; Max. oper. temp., 175°C.

MODEL 3280 Square, micro-miniature, wirewound; 100Ω to 50K; 1.0W; Max. oper. temp., 175°C.

MODEL 3011 High-temperature, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp. 150°C.

MODEL 220 Sub-miniature, high-temperature, wirewound; 100Ω to 30K; 1.0W; Max. oper. temp., 175°C.



MODEL 224 High-temperature, wirewound; 10Ω to 100K; 1.0W; Max. oper. temp., 175°C.

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MODEL 200 General-purpose, wirewound; 10Ω to 100K; 0.25W; Max. oper. temp., 105°C.

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MODEL 3500 Precision wirewound, 10-turn, bushing mount; 500Ω to 125K; 2.0W; ⅛" dia.; Max. oper. temp., 125°C.

MODEL 215 General-purpose, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp., 125°C.

MODEL 3510 Precision wirewound, 3-turn, bushing mount; 200Ω to 50K; 1.0W; ⅛" dia.; Max. oper. temp., 125°C.

MODEL 3067 Commercial, wirewound; 100Ω to 20K; 0.5W; Max. oper. temp. 85°C.

MODEL 3520 Precision wirewound, 5-turn, bushing mount; 200Ω to 75K; 1.5W; ⅛" dia.; Max. oper. temp., 125°C.

MODEL 3068 Commercial, Resiston® carbon; 20K to 1 Meg.; 0.2W; Max. oper. temp., 85°C.

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MODEL 3367 Single-turn, wirewound, sub-miniature; 100Ω to 20K; 0.5W; Max. oper. temp., 105°C.

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Increasing Bandwidth of Ultrasonic Radiators

Signal-to-noise ratio is also improved by propagating Rayleigh ultrasonic waves

By H. MACK THAXTON

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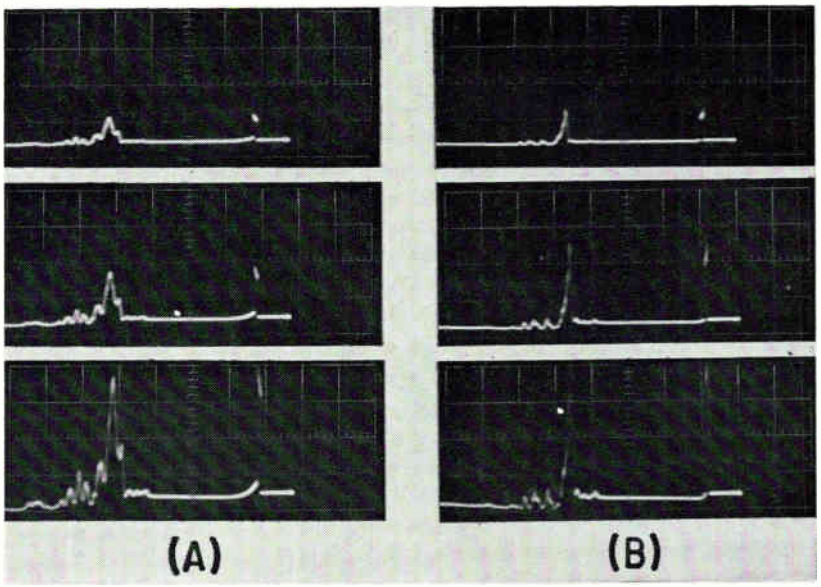


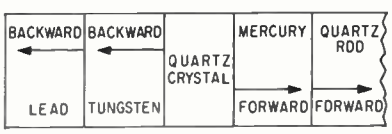
BANDWIDTH *of Rayleigh-wave pulse patterns using only lead backing (A) is increased using tungsten-lead system (B)—Fig. 2*

EXPERIMENTS indicate that bandwidth of an ultrasonic radiator may be increased while also increasing signal-to-noise ratio. The investigation also indicates that the magnitude of noise level is reduced by propagating Rayleigh waves.

Bandwidth of an ultrasonic radiator can be increased about 750 Kc by radiating into mercury[1] because of its high impedance. However, the increase in bandwidth is accompanied by a loss in efficiency in converting electrical to mechanical energy.

The series of experiments were undertaken to determine the extent that bandwidth could be increased by radiating longitudinal pulses into mercury and then converting to Rayleigh waves. Another objective of the project was to determine how much bandwidth could be increased with minimum loss in conversion efficiency by taking into account impedance considerations at the transducer.

The efforts to increase signal-to-noise ratio were concerned primarily with the effect on signal-to-noise ratio resulting from interference of backward reflections from the ultrasonic radiator. The propagation medium was assumed to be optical grade quartz rod adequately annealed to eliminate sources of reflective and interfering stresses and of impurities.



CONVERSION *efficiency of impedance-coupling system in transducer assembly determines extent of bandwidth increase—Fig. 1*

The impedance-coupling system at the transducer is shown in Fig. 1. Forward ultrasonic intensity is

$$I_F = 4e_{ik}^2 E^2 (R_q R_{hg} + R_q R_{hg} \tan^2 x_{hg}) / R_{hg} (R_q^2 + R_{hg}^2 \tan^2 x_{hg}) \quad (1)$$

and backward ultrasonic intensity is

$$I_B = 4e_{ik}^2 E^2 (R_w R_{pb} + R_w R_{pb} \tan^2 x_w) / R_w (R_{pb}^2 + R_w^2 \tan^2 x_w) \quad (2)$$

where e_{ik} is appropriate piezoelectric constant for the material in which i and k are integers; E is electric field amplitude; R_q, R_{hg}, R_w and R_{pb} are longitudinal impedances of quartz, mercury, tungsten and lead, respectively; $x_{hg} = 2\pi f T_{hg}/V_w$ in which f is resonant frequency, T_{hg} is mercury layer thickness and V_w is propagation velocity in tungsten; and $x_w = 2\pi f T_w/V_w$ in which T_w is tungsten thickness.

The ratio of forward to backward ultrasonic radiation intensity is

$$I_F/I_B = R_q \sec^2 x_{hg} (R_{pb}^2 - R_w^2 \tan^2 x_w) / R_{pb} \sec^2 x_w (R_q^2 + R_{hg}^2 \tan^2 x_{hg}) \quad (3)$$

If $k_w = 4e_{ik}^2 E^2 V_{hg}$, from Eq. 1:

$$dI_F/dx_{hg} = 2k_w R_q \sec^2 x_{hg} \tan x_{hg} (R_q^2 - R_{hg}^2)/V_{hg} (R_q^2 + R_{hg}^2 \tan^2 x_{hg})^2 \quad (4)$$

where V_{hg} is propagation velocity in mercury. Hence, for maximum intensity I_F, $\sec^2 x_{hg} = 0$ or $T_{hg} = \lambda/4$, where λ is wavelength. Similarly, from Eq. 2, $T_w = \lambda/4$ for maximum I_B.

Using the values of T_{hg} and T_w for maximum intensities, Eq. 3 reduces to

$$I_F/I_B = R_q R_w^2/R_{pb} R_{hg}^2 \quad (5)$$

Inserting the values of longitudinal impedance[2] for the materials,

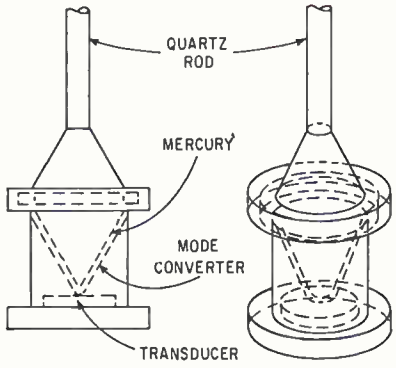
$$I_F/I_B = 15.51 \quad (6)$$

Signal-to-noise ratio using the results of Eq. 6 is thus $S/N = 23.8$. Similarly, the value of intensity for the system using lead backing alone is

$$I_F/I_B = R_q R_{pb}/(R_q^2 \cos^2 x_{hg} + R_{hg}^2 \sin^2 x_{hg}) \quad (7)$$

Signal-to-noise ratio is thus significantly improved using Rayleigh wave propagation.

Typical pulse patterns of Rayleigh waves obtained using the system with lead backing alone are shown in Fig. 2A, while the Rayleigh wave pulse pattern of the sys-



QUARTZ MODE *converter is used to obtain Rayleigh waves—Fig. 3*

tem in Fig. 1 is shown in Fig. 2B. Bandwidth of the patterns in Fig. 2A is 0.5 Mc and in Fig. 2B is 2 Mc. Driving resonant frequency is 5 Mc, and average attenuation is about 50 db in all cases. Velocity of the Rayleigh waves is 0.342 cm/μsec, corresponding to a delay of 350 μsec in a straight quartz rod.

The quartz Rayleigh wave mode converter is shown in Fig. 3.

REFERENCES

(1) W. P. Mason, "Electromechanical Transducers and Wave Filters," D. Van Nostrand Co., Inc., p 413, 1958.
(2) W. P. Mason, "Physical Acoustics and Properties of Solids, D. Van Nostrand Co., Inc., p 17.

New Optical Masers Use Dissociative Mechanism

PHYSICAL PRINCIPLE underlying operation of two new optical masers suggests a new family of these devices. Laser action results from dissociative excitation transfer.

One of the new lasers uses a mixture of neon and oxygen and the other a mixture of argon and oxygen. Both devices, announced by Bell Telephone Laboratories, radiate in the near infrared at a wavelength 8,446 angstroms. Thus the lasers also provide a new frequency for optical communications.

In dissociative excitation transfer, an excited atom of a noble gas such as neon breaks up an oxygen molecule. To operate the lasers, molecular oxygen is mixed with neon or argon, and the mixture is excited with an r-f discharge.

Energy transferred from the neon or argon to the oxygen molecule results in its dissociation into two atoms. One of the atoms immediately or very shortly after attains an excited state, from which it radiates at 8,446 angstroms.

The experiments suggest that the mechanism of dissociative excitation of a molecule by energy transfer from a metastable atom may be more useful in optical maser technology than the inelastic atom-to-atom collisions responsible for maser action in helium-neon mixtures. In the latter devices, electrons in the discharge created by the r-f generator excite helium atoms to their metastable state. This state is comparable to the upper state of neon. As a result, helium atoms can impart their energy to the neon atoms by collision. The neon atoms then radiate to a lower energy level.

Computer Study Planned Of Reactor Efficiency

PROCESS COMPUTER installation at a nuclear generating plant will provide information for improving reactor-fuel technology. Although it will not perform any plant control functions, it is expected to provide operating experience in using a computer to automate a nuclear plant.

The process computer will be used at the Big Rock Point Nuclear Power plant of Consumers Power Company, Michigan. Use of the computer was described in a paper by L. K. Holland and E. S. Beckjard, General Electric Atomic Power Equipment Department, at the American Nuclear Society Meeting in Boston.

The 40,000-word G-E 312 process computer will monitor reactor power level, thermal-hydraulic performance of the reactor core, neutron exposure of each segment of the fuel, instruments and reactor vessel. It will also be used to develop methods for achieving maximum fuel burnup by scheduling of control rods.

Comprehensive information obtained in the computer study will be used to improve operating efficiency, to simplify fuel inventory and plant management, and to improve power-producing capability of the fuel.

Measured coolant flow rates, temperatures and pressures will be used to calculate reactor power level. Readings of core conditions from 24 in-core ion chambers, accumu-

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lated constantly and stored in the computer memory, will assist in determining a finer power distribution in the reactor core. Predetermined control-rod sequences will be stored in the computer and monitored by the reactor operator for most efficient operation. The sequences are calculated from measured and computed reactor data, which is one of the major areas in the development effort of applying computers to nuclear plants.

The computer system will include the central processor, an input-output unit, computer control console, two operator control units, four logging and on-demand typewriters, and three punched paper tape units.

Bird-Brain Telemetry Is Used in Pigeon Study

TEL AVIV — Electroencephalograph has been developed that enables the brain impulses of pigeons to be recorded. The miniature telemetry system was developed at the Electronics Department of the Weizman Institute of Science at the request of the Institute of Physiology of Pisa University. The 1-ounce instrument occupies only 15 cubic inches.

The bird-brain project, as it is called, grew out of an earlier project in which a device was developed for telemetering the cortical activity of the brains of unrestrained cats. Special emphasis was placed on recording brain impulses during states of increased activity and convulsions of the unrestrained animals. An amplifier-transmitter weighing about 3½ ounces was mounted on the head of the cat, and data on feline cerebral action was telemetered to the physiologists.

As disturbances arising from general activity of the body of the subject animals and variations in electrode contacts were eliminated, records free of artifact interference were obtained. Further progress has enabled development of the 1-ounce amplifier-transmitter.

Other modifications were made to improve performance of the instrument. A differential amplifier was designed for bipolar recording. The circuit was also designed to reject in-phase signals from the power lines. Noise relative to the input has been almost completely eliminated.

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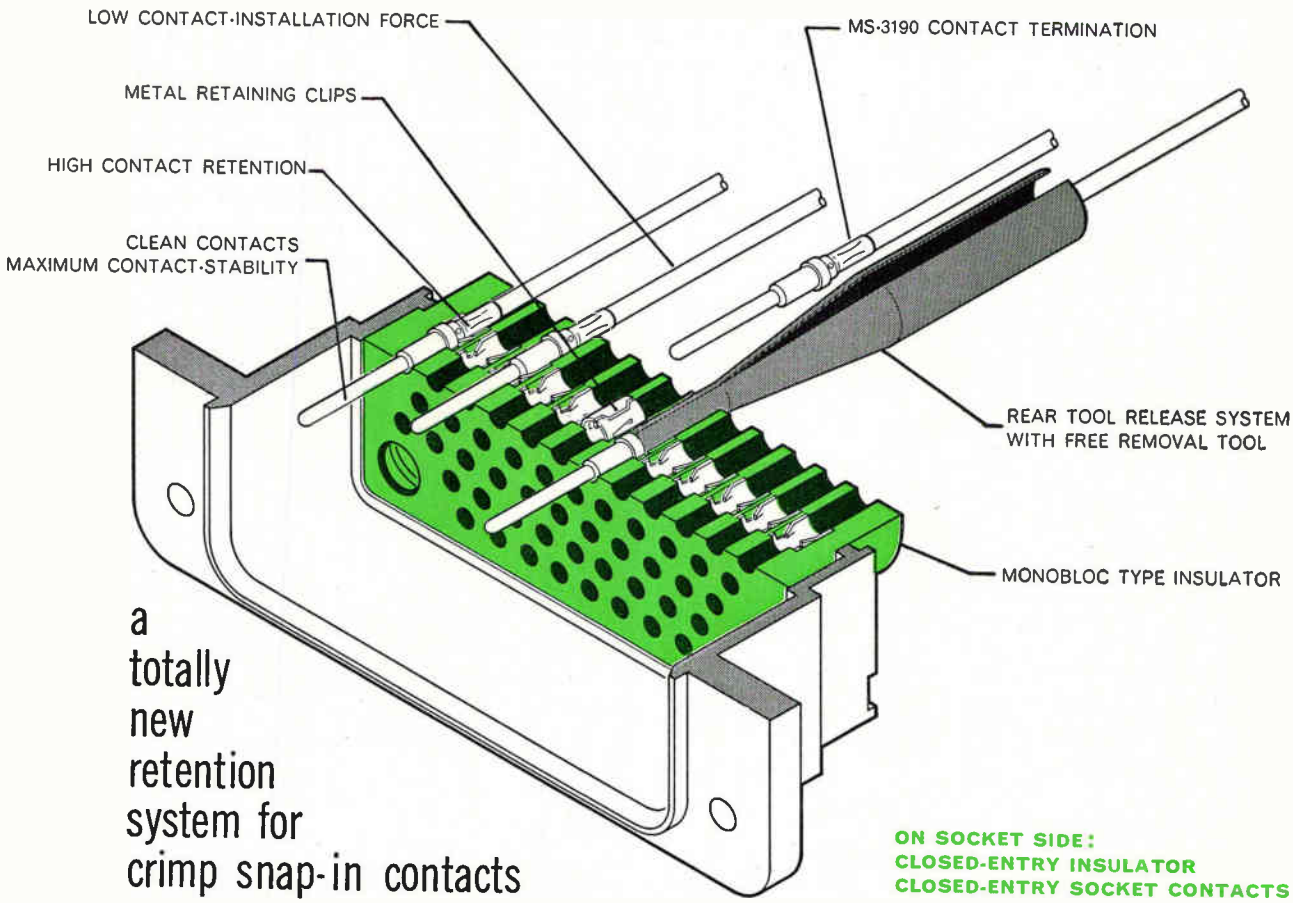

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CANNON PLUGS

July 6, 1962

CIRCLE 65 ON READER SERVICE CARD 65

Taking Bounce Out of Reed Relays

Recent improvements offer wider use for millisecond switching

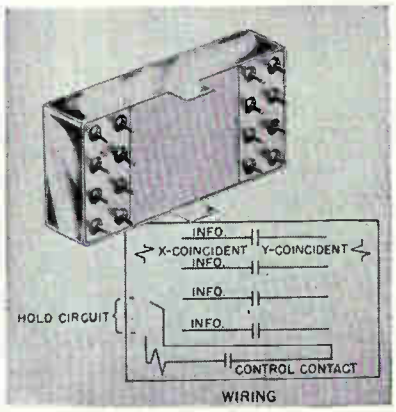
By HUGH CULLIN
Chief Engineer,
Struthers-Dunn, Inc.,
Pitman, N. J.

THE HEART of the reed relay is a magnetic switch sealed in a glass capsule that contains an inert gas (ELECTRONICS, Sept. 30, 1960, p 63). The magnetic switch consists of two nickel iron alloy reed elements having precious metal contact surfaces. The contact surfaces are normally open, closing when a magnetic field of proper strength is applied.

Since the introduction of reed relays a few years ago, their use has grown steadily. They are ideally suited for transistor drive applications and find wide use in data processing systems, ground control for missiles and satellites in weapons and in communications systems. Although reed switching is not fast enough for all computer applications, it is fast enough for some—switching information heads and voltage reference circuits, for instance.

MAGNETIC SWITCHES — Typically, reed switches operate in less than one millisecond including contact bounce time, and release in no more than 0.3 millisecond. The basic dry reed relay consists of one or more dry reed switches enclosed by a single direct-current magnetizing coil, with the necessary parts to hold the units together.

Typical contact rating for standard reeds is 15 watts, one amp or 250 volts resistive. Life expectancy is 20 million operations at maximum rating; 100 million operations at one-half maximum; 200 million at dry circuit level. Miniature reeds have typical contact ratings of 4 watts, 250 v max., 125 ma max. Life expectancy is 3 million operations at maximum rating; 10 million operations at one-half max.; 20 million at dry circuit level.



NEW MINIATURE *reed crosspoint relay for printed circuit cards features magnetic shielding and twist-tab mounting. Contact rating is 4 watts. Two coils are identical and act as X and Y coordinate coils with a third coil as the holding coil. Simultaneously energizing X and Y closes the contacts; these remain closed until holding coil is interrupted or until either X or Y is reverse-pulsed*

The glass-enclosed reed switch is completely impervious to atmospheric contamination. Further protection against damage and breakage is provided by molding both miniature and standard relays in an epoxy resin or in a metal enclosure with only the terminals exposed. Most standard size relays have one, two, four, six, eight, 12 or 20 poles; miniatures have up to 12 poles.

BASIC REED RELAY—This consists of one coil operating one or more reed switches, and it is used for conventional on-off switching. Standard coil voltages are 6, 12, and 24 v d-c.

Pulse reed relay combines one pulse coil and one holding coil operating one or more reed switches. The holding coil does not have sufficient power to operate a switch, but keeps it operated after the pulse coil has received the proper signal. The pulse coil operates the switch, independent of the holding coil, from a signal which is additive to the flux generated by the holding coil.

Crosspoint reed relays have one holding coil, two coincident current coils, and from two to five reeds including the control reed. Simultaneously energizing two coordinate coils closes one reed contact permanently wired in series with the holding coil. The holding coil then picks up and closes the information contacts. All contacts remain closed until the holding coil is externally interrupted, or until one of the coordinate coils is reverse pulsed.

Latch reed relay is magnetic latch reed with form A or form C contacts. A pulse to the coil of the relay keeps it closed until it is released by a reverse polarity pulse or pulse to another coil on the reed.

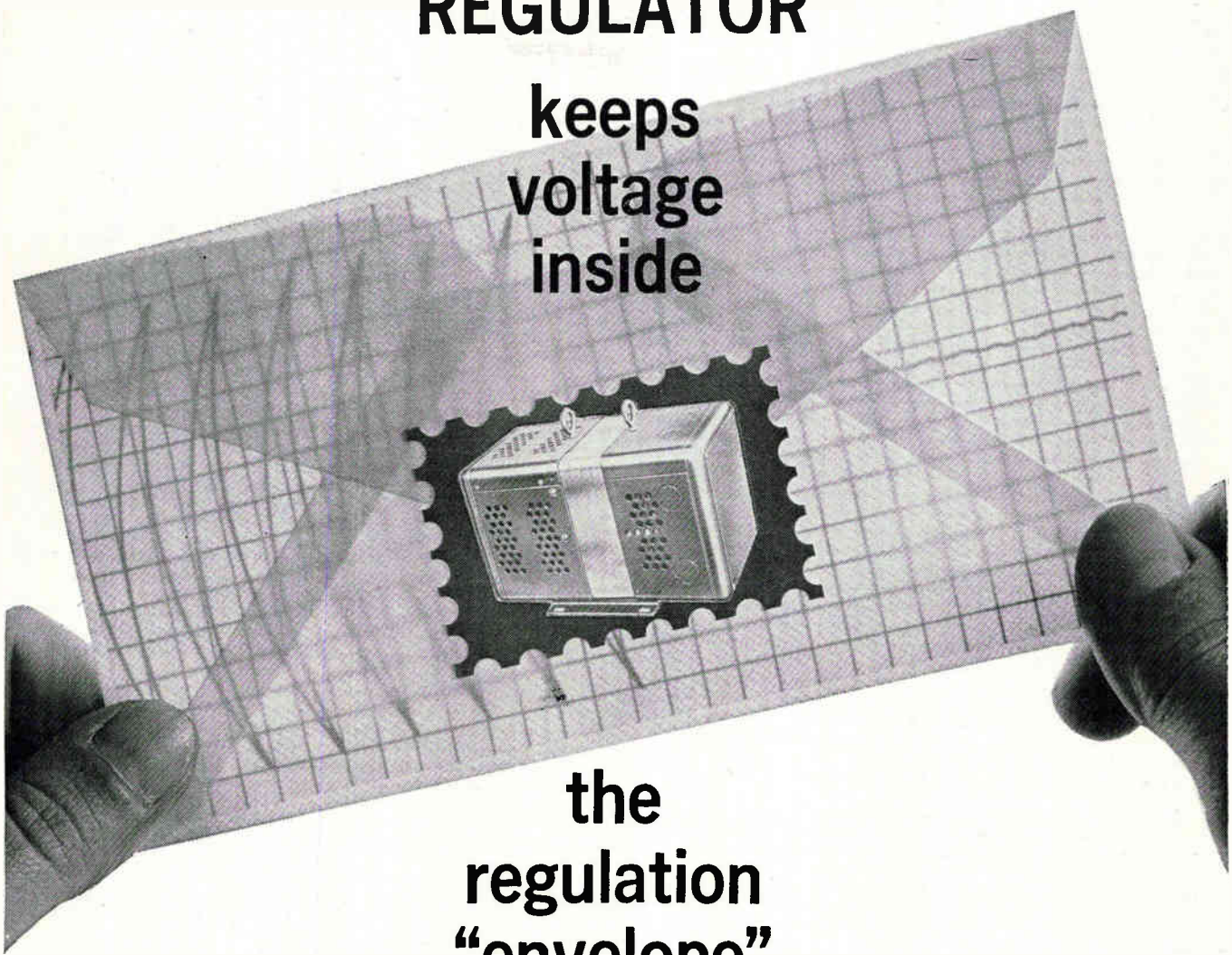
Logic reed relay has from two to five coils operating one or more reeds. Coils are designed so that various coil combinations must be energized at nominal power levels to operate the reed. For *and* operation, one coil and a second coil must be energized simultaneously. To prevent false contact closure, care must be taken not to overdrive or overpower any one of the coils. For *or* operation, either of two coils supplies sufficient power to operate the reed.

Infinite margin relay is a highly refined logic type for extremely critical circuits in an *and* arrangement. The second coil must be energized, even when one is greatly overpowered.

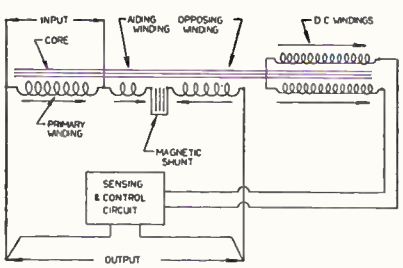
Early reed relays had long terminals of heavy magnetic metal. When they were clipped close to the board, the return path of the magnetic field was greatly reduced. Operating values often changed substantially. Bonding the reed ends of the terminals often affected their operating points.

MOST MODERN TYPES—Reed relays now terminate in non-magnetic tin-coated copper wires of about 0.030-in. diam, soldered internally to the reed ends. Clipping or bending has no effect on reed op-

SOLAtron LINE VOLTAGE REGULATOR



Starts corrective action the instant output departs from nominal... long before voltage even approaches the boundaries of the regulation envelope. In fact, response is *10 times faster* than mechanical regulators. Even under extreme conditions, return to nominal will *never* exceed 10 cycles. And no moving parts means no electro-mechanical wear. Maintenance is reduced to insignificant static-design proportions. A solid-state sensor triggers a magnetic flux "valving action" to maintain nominal voltage.



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eration, and they are easy to solder.

Reed relay lead terminals are now aligned on 0.2-in. grid spacings, and are brought out on one side of the relay enclosure for convenient printed board mounting without bending or cutting. Far more reed switching can be packed into less space than ever before.

In earlier types, the magnetic coupling effect between reeds operating in close proximity was close enough so that one reed would not drop out even though its coil circuit was de-energized. This difficulty is now greatly reduced by packaging reeds in magnetically-shielded enclosures.

With the variety of types now available, reed relays are being used in increasing number of applications. A new miniature reed relay in a magnetically-shielded case only 1.25 in. by 0.80 in. by 0.40 in. does the job of conventional can types in applications requiring long life and extreme contact reliability on dry circuit and light load switching.

Reed relays are not across-the-board substitutes for many switching applications, however. Their advantages and limitations must be weighed carefully in each circuit. Reed relays do offer the designer great latitude in placing components, they are adaptable to logic circuits, and their life is remarkable. The contact capsules are, however, somewhat limited in their contact ratings.

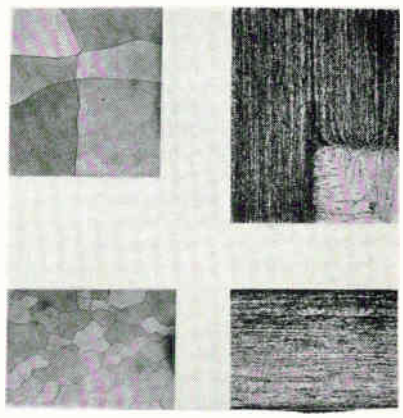
A RECENT DEVELOPMENT—Reed relay usefulness will be expanded as a true form C break-before-make reed with practically negligible bounce of its normally-closed contact. This design will greatly reduce form C unit costs.

The reed method of switching is less complicated and less expensive than solid-state switching, although the millisecond range of the reeds cannot approach the switching speeds of solid-state systems.

With solid state switching, many components and somewhat complicated circuits are required to produce a contact that is neither wholly *on* nor wholly *off*. Solid-state circuits are always partially *on*, basically representing a change from a low impedance to a high impedance circuit. And inputs and outputs are not isolated. Reed relays, on the other hand, provide positive *on* and positive *off* switching, and the inputs and outputs are isolated.

Developments indicate a real place for reed switches where rapid switching, minimum size, low operating power requirements, long life, reliability, and moderate cost are important factors.

New Technique Joins Refractory Metals

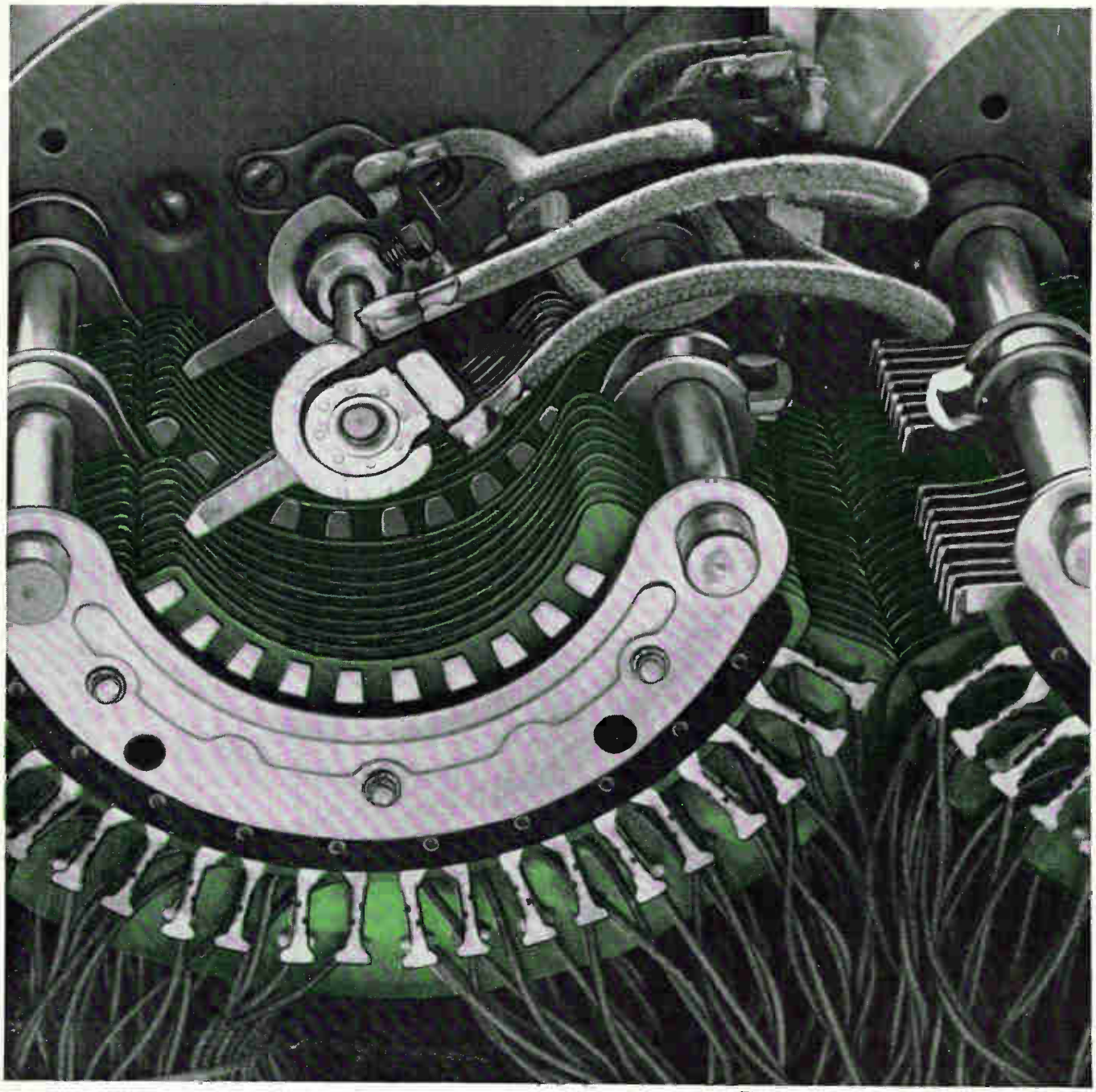


MICROSCOPIC *specimen of thin tungsten sheet, left. At right, a similar specimen joined by therochemical bond shows complete lack of crystallization apparent in photos on left*

BRITTLENESS caused by recrystallization from the heat of existing welding methods often contaminate surrounding areas, as well as weaken structural elements. A technique developed by Martin consists of thermochemically depositing a filler of the base metal between the metal sheets to be joined. This provides a firm bond in which the base metal grain structure is not recrystallized by high welding temperatures. This method permits wider use of refractory metals, particularly tungsten and molybdenum, in missile and space vehicles.

Filler refractory material is deposited in the joint by combined nucleation and reduction of refractory-bearing halogen gases. Heat is applied to the base sheet to be joined and the temperature of the entire operation kept below 1,500 deg F, well below the recrystallization temperature of these materials.

The method results in a filler material with a somewhat dendritic but fine grain structure having a hardness level equal to the base metal.



The insulation of "Mylar" is shown in green.

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"Mylar" today is the standard insulation in a wide variety of electrical/electronic applications. In motors, capacitors, switches and wiring, its superb dielectric, chemical and thermal properties guarantee years of trouble-free performance. The high performance of "Mylar" in thinner gauges frequently gives substantial savings—since you use less "Mylar" than conventional materials.

Additional cost reductions can come from design modifications and manufacturing economies. Why not investigate its unique properties in your application? Save time and money now by writing to: Du Pont Company, Film Dept., Wilmington 98, Delaware.

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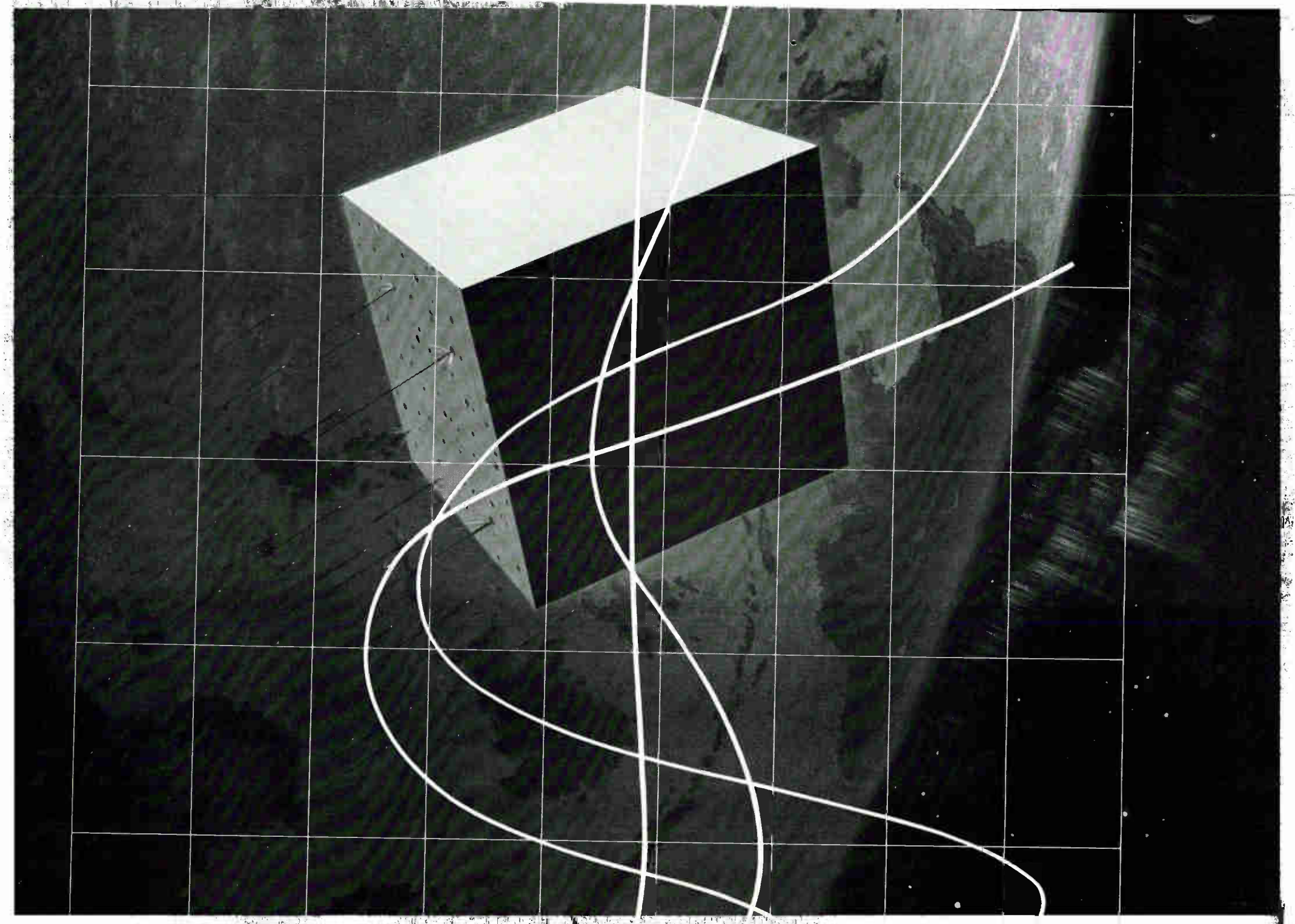

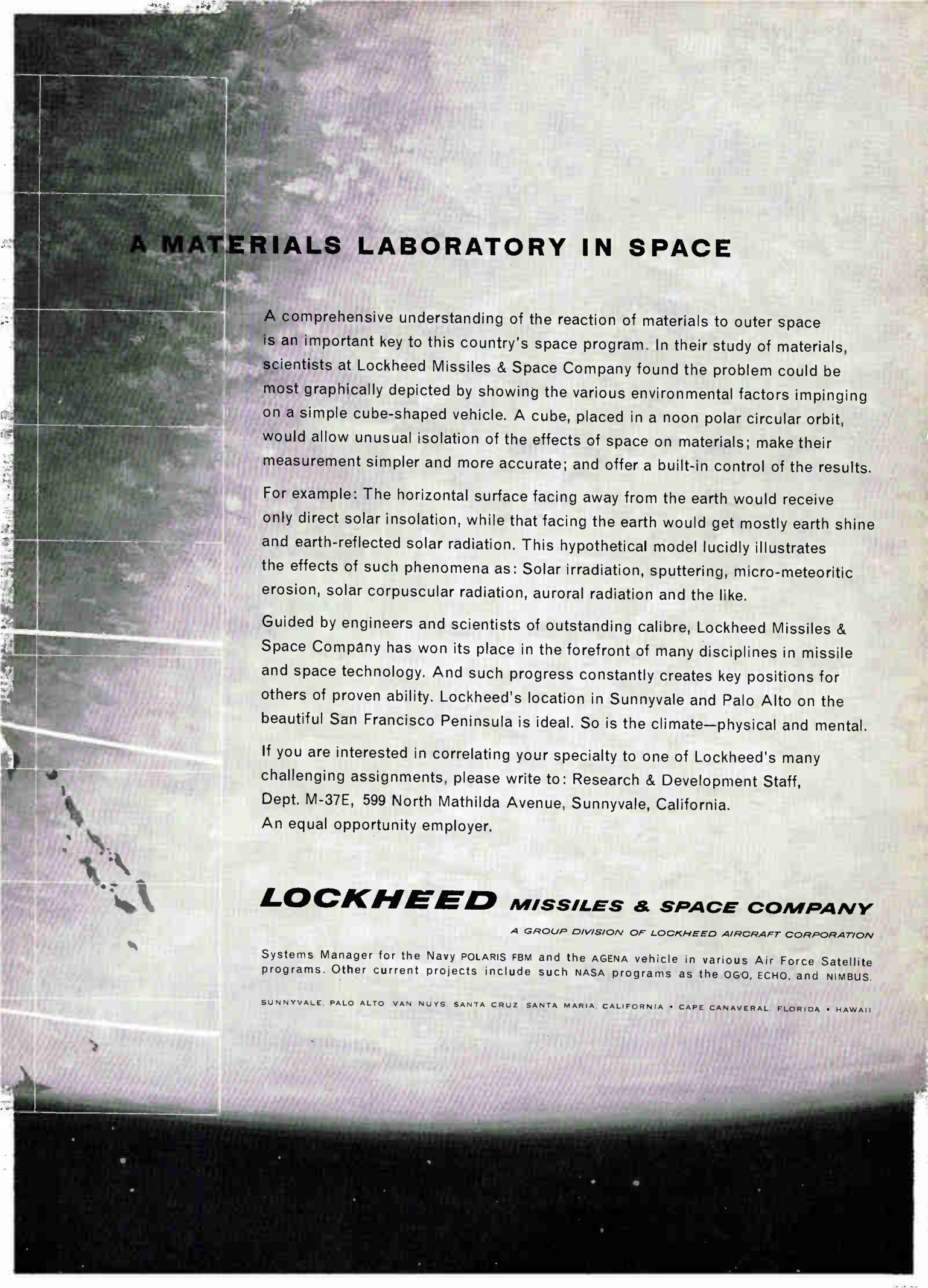

A MATERIALS LABORATORY IN SPACE

A comprehensive understanding of the reaction of materials to outer space is an important key to this country's space program. In their study of materials, scientists at Lockheed Missiles & Space Company found the problem could be most graphically depicted by showing the various environmental factors impinging on a simple cube-shaped vehicle. A cube, placed in a noon polar circular orbit, would allow unusual isolation of the effects of space on materials; make their measurement simpler and more accurate; and offer a built-in control of the results.

For example: The horizontal surface facing away from the earth would receive only direct solar insolation, while that facing the earth would get mostly earth shine and earth-reflected solar radiation. This hypothetical model lucidly illustrates the effects of such phenomena as: Solar irradiation, sputtering, micro-meteoritic erosion, solar corpuscular radiation, auroral radiation and the like.

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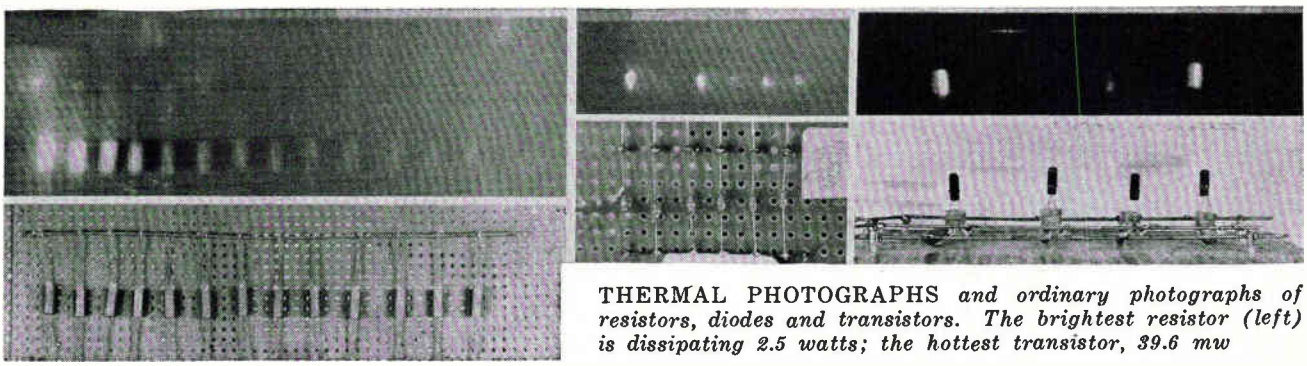


THERMAL PHOTOGRAPHS *and ordinary photographs of resistors, diodes and transistors. The brightest resistor (left) is dissipating 2.5 watts; the hottest transistor, 39.6 mw*

Circuit Inspections Speeded with Infrared

Nondestructive test method quickly shows up defective components and wiring

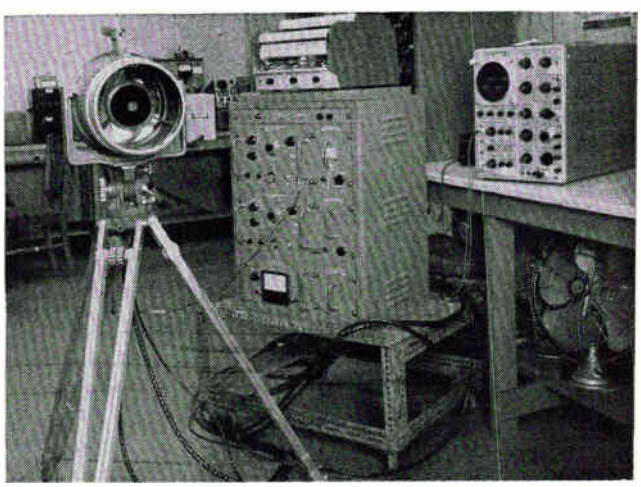
INFRARED RADIATION from electronic components is being used to determine whether a circuit is operating correctly and at design levels or whether some defect in wiring or circuit device is causing overheating. According to the technique devised by Riccardo Vanzetti, Equipment division of Raytheon Co., circuits can be checked while operating, using either an infrared scanning camera or an infrared radiometer.

The infrared camera takes thermal photographs of operating circuits. Current passing through wires and components causes heating and thus increases infrared emission. By scanning the circuit a line at a time and converting the infrared picked up from each point into an equivalent visible light signal (see sketch), a thermal picture of the circuit is obtained. When this photograph is compared with a previously made standard, open circuits and overloaded components are immediately pinpointed.

The infrared camera used to take the accompanying thermal photographs of resistors, diodes and transistors is a Barnes Model I-8A equipped with Polaroid film. Since the light source is essentially the circuit itself, no other illumination is required. From 3.25 to 13 minutes (depending on width and height of scan) are required for each photograph. As the photographs show, the hotter the component the brighter the equivalent image on film. The brightest resistor in the illustration above is operating at 2.5 watts and the one next to it is operating at 1.45 watts. The dissipation of the remaining resistors shown in progressively less and the farthest right resistor is operating at only 0.045 watts. The circuit board beneath the hottest resistors is also heated and several of the connection points are hotter than the current carrying wires.

The brightest of the six diodes, above, is operating at 31.5 mw and the coolest at 6.05 mw. The transistors are operating at, from left, 39.6 mw, 9.9 mw, 14.9 mw and 30.7 mw.

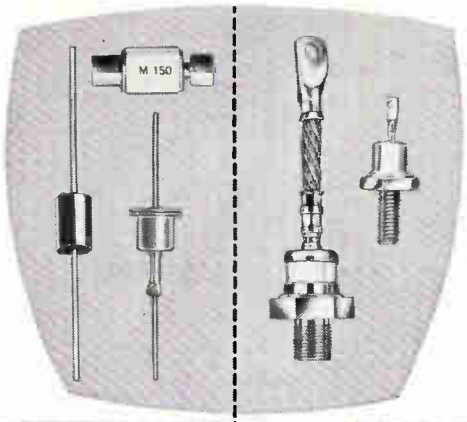
Thermal photographs are useful



INFRARED CAMERA *(left) showing adjustments (but not electronic circuits) and light sensitive camera back. Radiometer and electronic circuits (right) with recorder*

Low Current Silicon Rectifiers

22 types, with ratings from 0.15 amps to 1.50 amps; 100 to 2800 piv.
Send for Bulletin 62CC4.



Hermetically Sealed Silicon Rectifiers

Ratings from 2 amps to 250 amps; 50 to 600 piv; choice of positive or negative base polarity in most styles.
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Controlled Silicon Rectifiers

Two series, 3 and 5 amps; 25 to 400 piv. Stud mounted and hermetically sealed.
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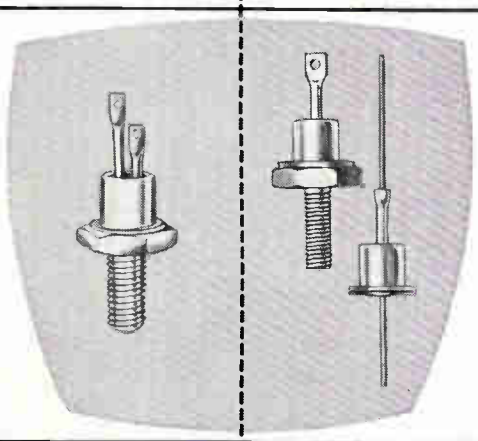

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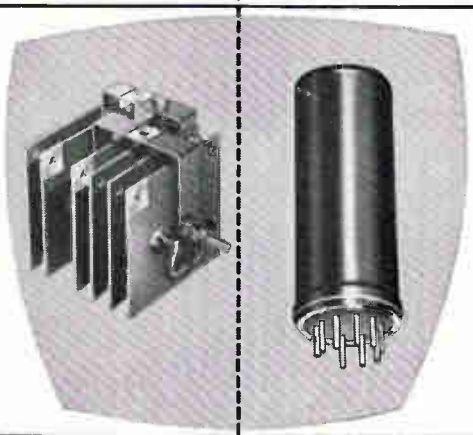
Silicon Rectifier Assemblies

336 types, ratings from 5 amps to 1250 amps; 50 to 500 piv. Configurations include single-phase bridge and center-tap, and three-phase half-wave, bridge, and full-wave center tap. *Ask for Bulletin 62SA3.*



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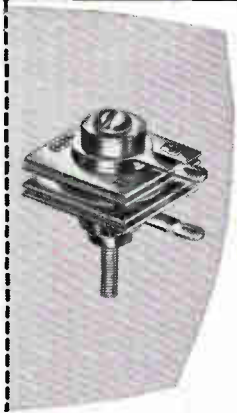

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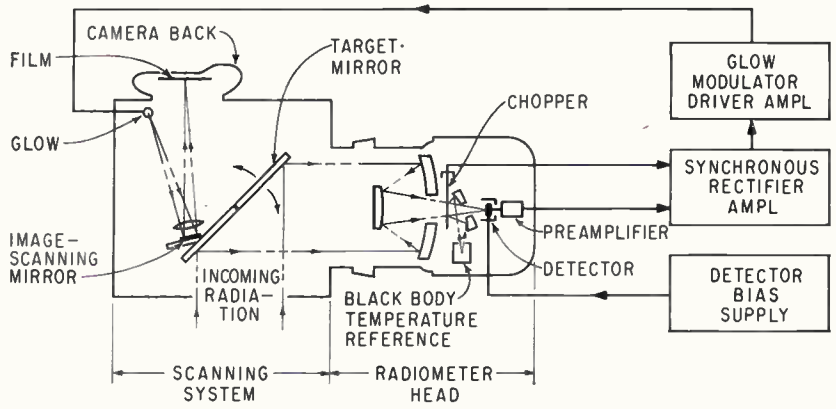
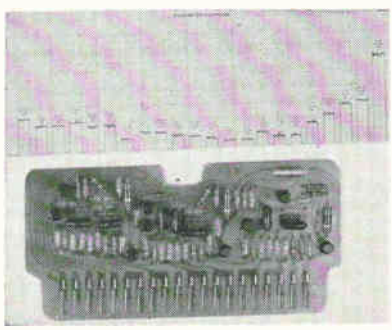


SCANNING MIRROR *directs light to infrared detector. Amplifying circuit drives glow tube to produce a line of varying intensity on film. Scanning mirror has quick return and tilts to cover a field 20 degrees wide and 5 to 10 degrees high*



CIRCUIT BOARD *and radiometer recording for normal operating conditions. Recordings (and ir photographs) can be used as inspection standards*

for many type of nondestructive testing but they are not as accurate in determining absolute current flow or device dissipation as a radiometer. The radiometer, however, must be pointed at each component being measured, and its output is typically applied to a servowriter or recorder. One of the illustrations shows a circuit board and the radiometer recording developed from it during an operating test. The radiometer used to take the readings has a field of view of about 4 mm² and a theoretical temperature resolution of 0.005 C. Power in electronic circuits can be determined to 0.01 milliwatt with radiometer techniques.

APPLICATIONS—Applications of infrared circuit inspection include design engineering, production line inspection, and quality control and reliability studies.

In design engineering, measuring instruments sometimes introduce excessive loading, while temperature measurements can be upset by the thermal capacity of the measuring probes. Infrared inspection methods do not introduce either of these two complicating factors.

For production line inspection and quality control of complex electronic equipment, infrared techniques are capable of faster and more comprehensive evaluation than conventional methods, which usually consist of measuring voltage, current and resistance at key points in the circuit. Conventional trouble shooting may require that suspected components be disconnected from the circuit or replaced, and assemblies such as computer boards containing thousands of components may take several days to correct. With infrared techniques, defects such as incorrect wiring, shorts, opens, poor connections, and defective components become apparent by comparing two pictures or two recordings.

Radiometer inspection can be automated with straightforward methods. Radiometer output can be compared electronically with a standard recording and components above or below tolerances can be indicated by IBM cards or in other ways.

X-Ray Inspection with Television Display

AN X-RAY-SENSITIVE closed circuit tv system that eliminates any need for intermediate imaging devices has been developed by Ohio State's

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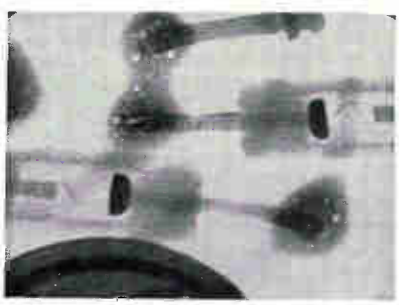
CIRCLE 75 ON READER SERVICE CARD

department of welding engineering.

Inspecting electronic printed boards, the tv x-ray imaging system detects semiconductor and solder porosity, missing solder at terminals, diode contamination, broken wires, and breaks in copper conductors. Small closed assemblies such as relays, geared assemblies, springs, ratchets, and contacts can all be observed if x-rays of sufficient intensity are used to penetrate case materials. It shows considerable promise as a useful tool in military and industrial applications where x-rays are needed to inspect continuous production techniques.

Instantaneous image reproduction would allow considerable reduction in production inspection costs, according to the developers. Observing personnel would also be protected from exposure to heavy ionizing radiations from industrial x-ray sources.



ONE-INCH *diameter x-ray sensitive camera is used to develop image on 17-inch picture tube*

The ¾ by ½ inch sensing area of the one inch x-ray sensitive camera tube delivers a 30 diameter enlargement on a 17-inch picture tube. This is about the optimum possible enlargement without introducing objectionable scan lines, according to the research team.

X-ray sensing vidicon camera tubes constructed to order by Machlett labs are similar in size and appearance to conventional photoconductive vidicon tubes, but include special windows and target materials. Beryllium's inherent transparency to x-rays is reported to offer tube windows about 1.8 times more sensitive than glass.

The x-ray sensitive camera tube operates similarly to the ordinary light sensitive vidicon tube to develop an electrical signal.

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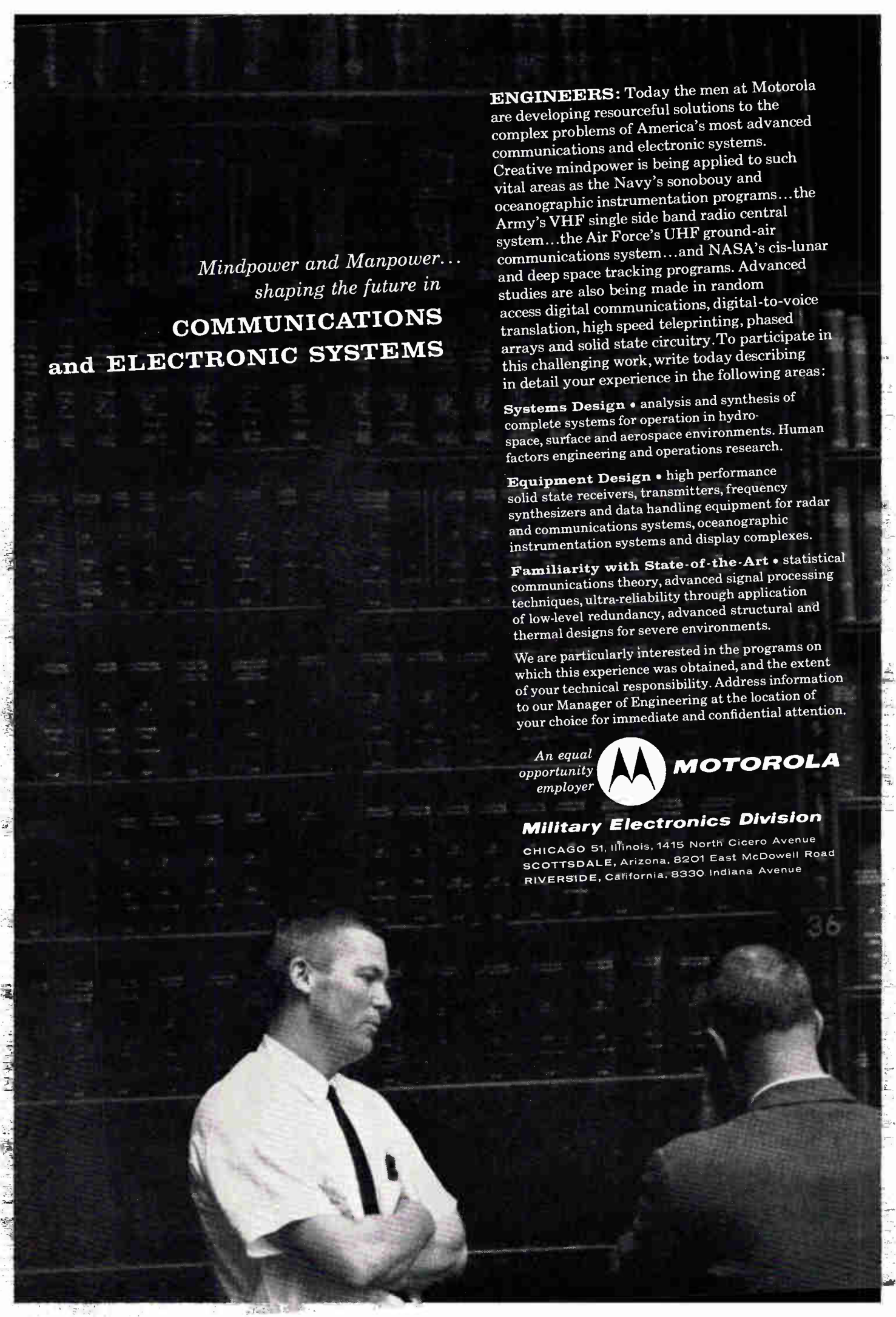

a complete line of versatile modules for the design or test engineer

DECADE TRANSFORMERS RESISTORS ▪ CAPACITORS ▪ INDUCTORS

Arnold digiboxes are designed as functional tools to provide direct visual presentation of component values.

These compatible laboratory-quality instruments can be quickly interconnected to provide a highly-reliable means of circuit simulation . . . digital adjustment of design parameters . . . fast evaluation of component tolerances.

Four units described below are first of a continuing line of associated devices. Future designs include: power supplies, transistor modules, meters, amplifiers, signal transformers, and voltage dividers.

Small size. All units are 4" x 5" x 3" high.

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FREE . . . complete set of 4 DIGIBOXES, and 9 individual DIGIBOXES of your choice will be awarded for the most unique ideas in the ARNOLD DIGIBOX APPLICATIONS CONTEST.

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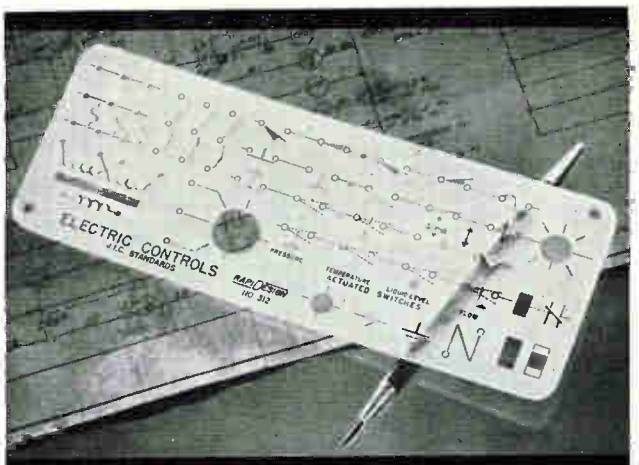
VERMONT 7-5313 — UPTON 0-6284



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ELECTRONIC CONTROLS TEMPLATE
ACTUAL SIZE 9" X 3¾"

J. I. C. STANDARD SYMBOLS AS RECOMMENDED BY THE JOINT INDUSTRIAL CONFERENCE IN MARCH 1953.

DESIGNED TO ASSIST IN THE DEPICTION OF CIRCUITS IN ELECTRICALLY CONTROLLED MACHINERY AND ELECTRIC AUTOMATION OF PRODUCTION PROCESSES.

MADE OF .030 MATTE FINISH MATHEMATICAL QUALITY PLASTIC.

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Economical • Reliable • Effective

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Type 14C Microwave Radio Terminals

provide needed communication and data transmission for railroads, telephone companies, public utilities, public safety services and the armed forces.

Whether for a "thin-route" gap filler or a 48-channel multi-hop system, Budelman Type 14C, 1700-2300 MC Microwave and Speech Multiplex equipment "proves in" where others cannot.

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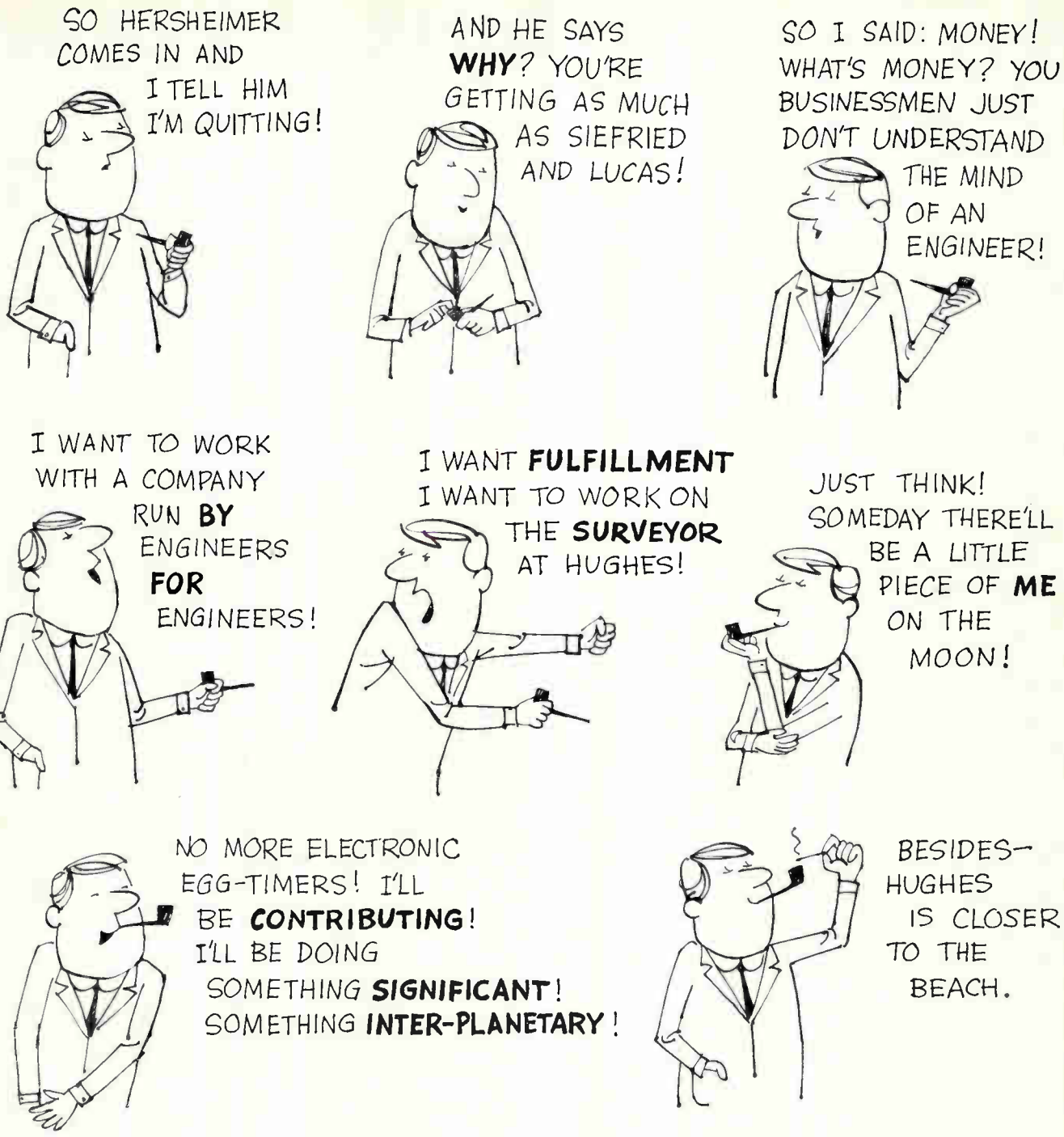

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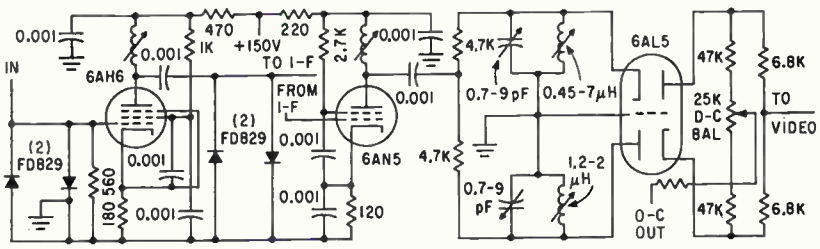


High-Speed Diodes Make Limiting Smooth

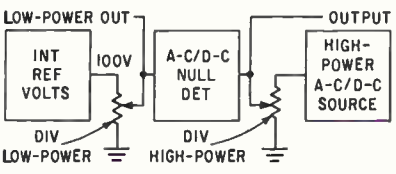
Features linearity to 1% and peak-to-peak video output capability of 35 volts

MANUFACTURED by RHG Electronics, 94 Milbar Blvd., Farmingdale, N. Y., the models D606 and D306 limiter discriminators have 8 Mc peak-to-peak bandwidth, 5-percent linearity over a 6-Mc bandwidth, 0 dbm sensitivity for hard limiting, video output of 5 v/Mc and direct-coupled output of 2 v/Mc. The D606 is centered at 60 Mc and D306 is centered at 30 Mc. Some novel techniques are used in this device (see sketch). First is the use of ultra high-speed silicon diode pairs in two stages as limiters. Very smooth limiting is assured with no reversals and no time constant problems. Since these diodes can switch in nanoseconds, they can limit to beyond 100 Mc. The second design feature is the discriminator. Conventional discriminators use complex transformers or capacitative coupling to the tank circuits. The discriminator shown in the sketch consists of two single poles resistively coupled to the driving tube. Tuning can be accomplished without interaction. Semiconductors are not used because of temperature sensitivity and resultant detuning. In this device, temperature stability of the crossover frequency has been obtained to as low as 10 ppm/degree C. These units can be used in telemetry, measurements involving instantaneous frequency resolution, frequency shift during a pulse (observable as a-m on the video output), highly accurate afc systems and conventional f-m systems.

CIRCLE 301, READER SERVICE CARD

Portable Reference Supply For Meter Calibration

ANNOUNCED by Tensor Electric Development Co. Inc., 1873 Eastern Parkway, Brooklyn 33, N. Y., the model 5890 portable reference supply can be used for meter calibration, a source of accurate a-c/d-c voltage up to 1 watt, an accurate a-c/d-c voltmeter in the 0 to 100 v range and a general source of a-c or d-c voltages. Output is 0 to 100 v, a-c or d-c, in four ranges; 0 to 0.1, 1, 10 and 100 v to 1 watt. Accuracy is ±0.25 percent of set voltages above 0.01 v and ±0.2 percent of set voltage (+5 μv) below 0.01 v. After 15 minute warmup, output voltage will remain within specifications for at least 5 minutes without readjustment. Provisions are made to accommodate external a-c inputs at frequencies other than 60 cps. Loading with high power output is up to 10 ma at any voltage and low-power output loading is 2.5 megohm minimum load impedance. The internal reference voltage is compared to a zener reference in a bridge circuit and standardized by balancing a reference galvanometer. The desired voltage can be set on the low power divider in direct reading digital form. Divider output can be used directly without sacrificing accuracy if load impedance is greater than 2.5 megohms. For lower load impedances, the output terminals are used. To use as a voltmeter, unknown voltage is substituted for high power. (302)



Amplifier for Low-Level Bioelectrical Signals

NEW for Biocom Inc., 5883 Blackwelder St., Culver City, California, the model 120 bioamplifier is used for acquisition of such low-level signals as eeg, ekg, emg and fetal ekg. It features a differential gain

NEW

FROM WEINSCHEL...

BLUE LINE General Utility Coaxial Components

RUGGED STABLE MODERATELY PRICED

Now the same ruggedness and stability which has marked Weinschel Precision Coaxial Devices for years is available in a lower priced line of general utility components. **Blueline** is a new series of coaxial attenuators and terminations designed for applications where price and performance are important but a high degree of precision is not required.

Despite their lower price, **Blueline** units will use Weinschel's own film resistors which give excellent shock and vibration resistance while assuring stability under temperature and humidity cycling. These resistors are capable of withstanding appreciable peak pulse powers and reasonable overloads without changes in characteristics.

Specifications for the Model HF-N **Blueline** Attenuator and the Model CT-N **Blueline** Termination are given below. For complete information on **Blueline** components, contact Weinschel Engineering, Kensington, Maryland.

THE BLUE LINE MODEL HF-N ATTENUATOR

SPECIFICATIONS

Nominal Attenuation:	3 db, 6 db, 10 db and 20 db
Frequency Range:	2 to 10 KMC for 3 db, 6 db and 10 db units 2.5 to 10 KMC for 20 db units
Impedance:	50 Ohms
Average Power:	5 watts for 3 db units; 3 watts for 6 db units; 1 watt for 10 and 20 db units
Peak Power:	10 kw for 3 db units; 6 kw for 6 db units; 2 kw for 10 db units; 1 kw for 20 db units
Maximum VSWR:	1.35 for 3 db and 6 db units 1.40 for 10 db and 20 db units
Connectors:	Type "N", one male and one female.
Price:	**$25.00**
Delivery:	From stock

Blueline components are produced and sold by Weinschel Engineering, one of the most respected names in the precision components field. For your more exacting requirements, we invite you to inquire about Weinschel Precision Attenuators and Terminations.

THE BLUE LINE MODEL CT-N TERMINATIONS

SPECIFICATIONS

Frequency Range:	DC to 10 KMC
Impedance:	50 Ohms
Average Power:	1 watt
Peak Power:	1 kw (maximum pulse duration, 5 microseconds)
Maximum VSWR:	DC to 3 KMC-1.10 3 to 10 KMC-1.25
Connectors:	Type "N" male or female
Price:	**$25.00**
Delivery:	From Stock

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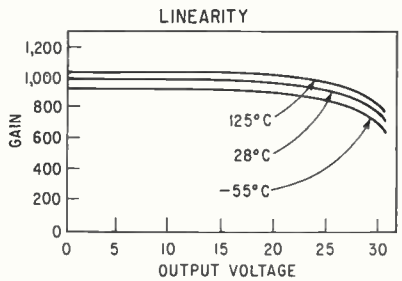
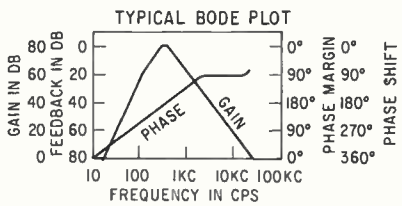
of 6,000, has an input impedance of 0.5 megohms, output impedance of 30,000 ohms, frequency response between 0.4 cps to 5 Kc, common-mode rejection of 80 db minimum, noise level of 3 μv peak-to-peak, and is less than ¾-cubic inch in size. The unit is essentially three differential stages. The first is an emitter follower for high input impedance. Low noise level is obtained by operating this stage at hushed levels. Common mode rejection balance is accomplished by balancing emitter currents in the first stage. Following two stages are long-tailed pair differential amplifiers. Construction is three-dimensional cord-wood method. Dynamic range is between the low microvolt level up to two to three millivolts. Price is $195.

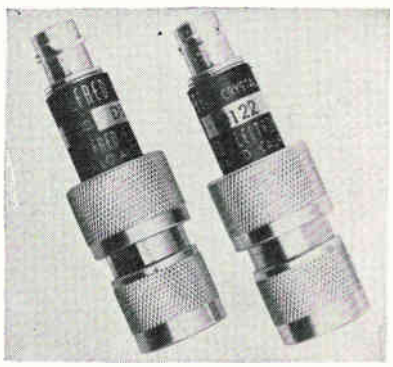
CIRCLE 303, READER SERVICE CARD





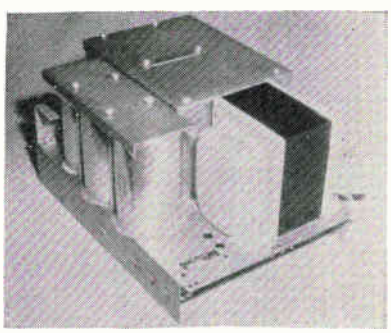
Servo Amplifier Features 5 Watts in 1 Cubic Inch

RECENTLY ANNOUNCED by Clifton Precision Products Co. Inc., Marple at Broadway, Clifton Heights, Pennsylvania, the SA 2802 servo amplifier is a variable gain, high-performance servo amplifier using over 20 db negative feedback plus internal feedback over the various stages. Preamplifier stages use d-c stabilization and a two-stage, push-pull output provide a phase shift on saturation of less than 10 degrees. With a suitable load, the unit will provide 5 watts of output power at 40 v rms over a temperature range from −55 to +125 C with a frequency range between 380 and 420 cps. Power required is 28 v d-c and maximum efficiency of 70 percent with zero-signal drain of 40 ma is typical. The large feedback factor is coupled with a gain margin of 20 db and phase margin of 70 degrees. Low input impedance (approximately 2,000 ohms) allows use as a summing amplifier via multiple input resistors. A voltage gain of 60 ± 1 db is obtained with phase shift of 180 ± 6 degrees with a 10,000-ohm input resistor. Gain is inversely proportional to input impedance with 66 db maximum. (304)



Crystal Detectors Come in Matched Sets

ALFRED ELECTRONICS, 3176 Porter Drive, Palo Alto, Calif., has available matched crystal detector sets for 1 to 11 Gc operation. The sets are matched to ±½ db for frequency and ±1 db for square law response. Models D121, -2, and -3 operate from 1 to 4, 4 to 8 and 7 to 11 Gc respectively. Sensitivity is greater than 0.1 v/mw at rated video load. (305)



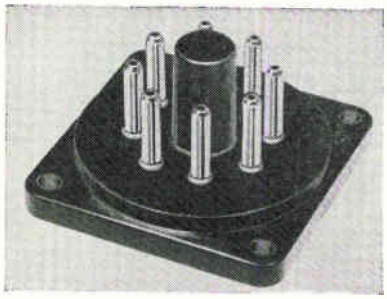
D-C Power Supply in Modular Form

DRESSEN-BARNES ELECTRONICS CORP., 250 N. Vinedo Ave., Pasadena, Calif. Model 24269 150 v, 1 amp modular d-c power supply is 8⅜ in. wide by 12½ in. long by 7 in. high. Device is completely solid state;

series regulator circuit driven from differential amplifier using Zener reference. Temperature coefficient is typically 0.03 percent per deg C. Price is $350. (306)

Video Amplifier Tube Uses Strap Frame Grid

SYLVANIA ELECTRIC PRODUCTS INC., 1100 Main St., Buffalo 9, N. Y. The 6JT8, a triode-pentode, offers high performance and, if desired, permits removal of one of the i-f stages. Constructions include a T9 bulb and miniature 9 pin base. Combined with the pentode video section in the envelope is a general purpose medium mu triode intended for use as a voltage amplifier or sync separator. Structure features the strap frame grid in combination with a flat Bikini type cathode. (307)

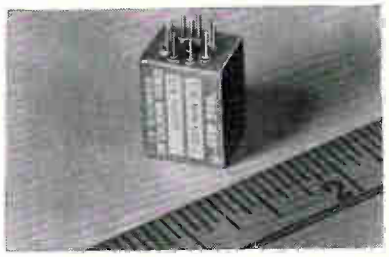


Molded Header Comes in Octal or Eleven Pin

CATON INDUSTRIES, 646 W. First Ave., Roselle, N. J., offers a molded thermosetting plastic module header with octal or 11 pin configuration for use on relay, amplifier, filter, logic packages, etc. It has a four hole mounting flange; holes are on

1⅛ in. centers. Outside dimensions are 1⅜ in. by 1⅜ in. Material is general purpose phenolic.

CIRCLE 308, READER SERVICE CARD



Magnetic Modulators Microminiaturized

GENERAL MAGNETICS INC., 135 Bloomfield Ave., Bloomfield, N. J. New Micro Mag Mods provide absolute reliability and infinite standby and service life. Features: broad bandwidth, carrier frequencies as high as 1 Mc, input signal current resolution better than 0.01 μa, low milliwatt power consumption. **(309)**

Amplifier-Meter Monitors G-Level

COLUMBIA RESEARCH LABORATORIES, MacDade Blvd. & Bullens Lane, Woodlyn, Pa. Model 6003-1/6A03 amplifier-meter system permits the simultaneous monitoring from three channels during vibration tests with piezoelectric accelerometers while operating into a recording oscillograph or magnetic tape equipment. **(310)**

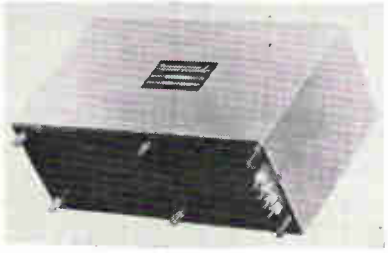
Versatile Generator For Sine and Square Waves

PRECISION APPARATUS CO., INC., 70-31 84th St., Glendale 27, L. I., N. Y. Model E-330 has coverage of 7 cps to 750 Kc (sine and square wave) in 6 bands. It provides complete signal facilities for a wide variety of audio and video test sit-

uations. Frequency accuracy is ±5 percent. **(311)**

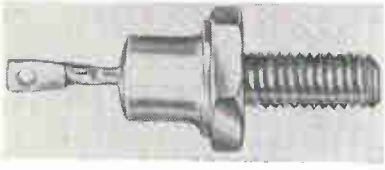
Decade Capacitor Comes in a Compact Unit

ARNOLD MAGNETICS CORP., 6050 W. Jefferson Blvd., Los Angeles, Calif. Model CDB provides direct digital presentation of component values. Operating range is 0 to 0.9999 μf, in steps of 100 $\mu\mu$f. Accuracy: ± 1 percent. Frequency range: 30 cps to 200 Kc. Size: 4 in. by 5 in. by 3 in. high. **(312)**



D-C Power Modules Are All Solid State

TECHNIPOWER, INC., 18 Marshall St., South Norwalk, Conn., has extended its line of power modules to the 300 w power level. Line extension includes 46 models covering the range of 3 to 250 v. Either 0.05 or 0.5 percent regulation accuracy is available at any voltage level. Ripple options are either 1 or 5 mv rms maximum. **(313)**

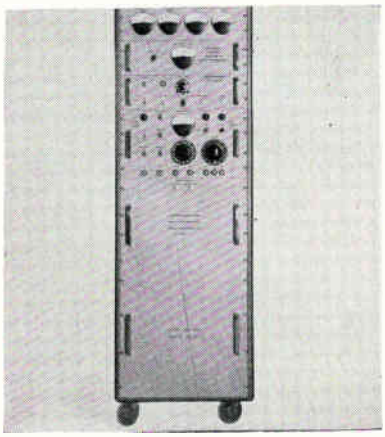


Sealed Rectifiers With 12-Amp Max

SARKES TARZIAN, INC., 415 N. College, Bloomington, Ind., offers series 2 hermetically sealed rectifiers with d-c load current ratings of 12 amp max. Peak inverse ratings of

100 to 600 v are offered in 100-v increments. Mounting is simplified by a choice of base polarity. Prices range from approximately $3 to $9 in sample quantities.

CIRCLE 314, READER SERVICE CARD



Soft Tube Modulator Uses Modular Construction

AMULEX ELECTRONICS, INC., 467 Connecticut Ave., S. Norwalk, Conn. Model STM-1MW-6250 is representative of a line of soft tube modulators ranging from 250 Kw through 25 Mw. Equipment features modular design, providing flexibility and economy through interchangeability of modules, which are also available for purchase on an individual basis. Price for unit pictured is $4,975. (315)

Gage Block Calibrator

TEXAS INSTRUMENTS INC., 3609 Buffalo Speedway, Houston, Texas, Model GBC-1 optical gage block calibrator provides simple, precise calibration of gage blocks for flatness, parallelism, surface quality and length. (316)

90 to 650-Kc Oscillator Is Crystal-Controlled

REEVES-HOFFMAN DIV. of Dynamics Corp. of America, Cherry and North Sts., Carlisle, Pa. Model S1331, for the 90 Kc to 650 Kc range, performs to the demanding

MIL-E-19400 specification for airborne sonar. Output is sinusoidal, 1 v, rms, across a load of 3,000 ohms. Frequency deviation is ±0.015 percent over a temperature range of from −30 C to 55 C. Oscillator requires input power of 10 ma, 30 v, d-c. Approximate size, 1 by 4 in. (317)

Electronic Teletypewriter

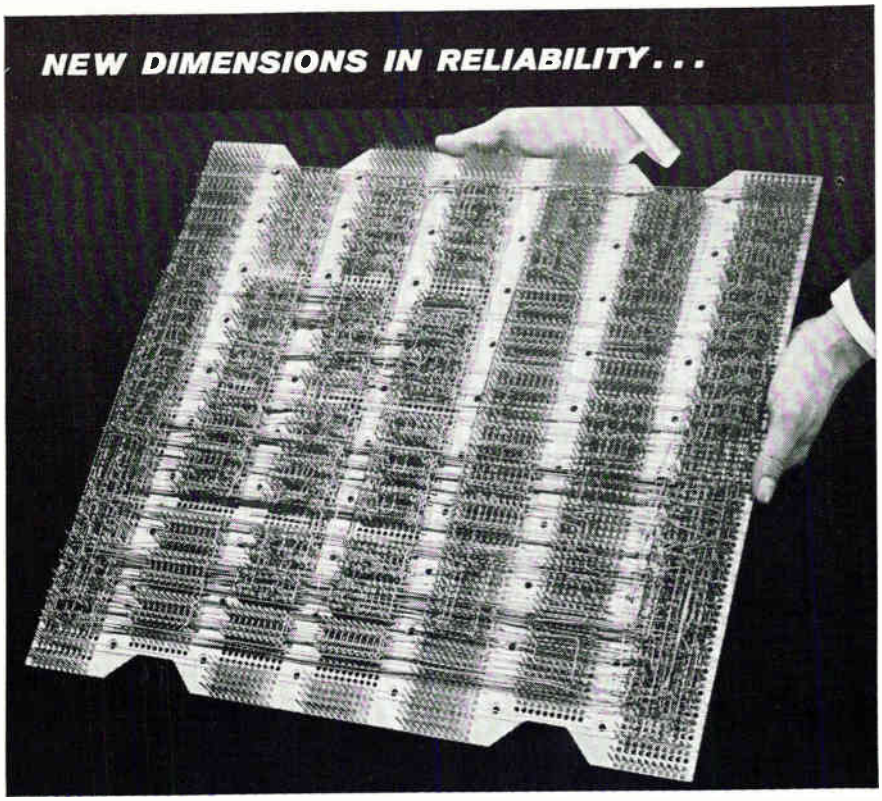
SMITH-CORONA MARCHANT INC., 410 Park Ave., New York 22, N. Y. Model 311 transistorized teletypewriter receives data in serial or parallel form. It is capable of handling both standard, 60 to 100 word per min direct wire communications, as well as input and output for computers requiring high speed, line at a time printing. (318)

Transformer Can Be Used for Current Pulses

BURMAC ELECTRONICS CO., INC., 24 Central Drive, Farmingdale, N. Y. The CV series of transformers are used to view and to measure current pulses in the range of a few amperes to up to 2,000 amp, peak pulse, without disturbing existing circuitry. Pulse widths reproduced by the transformers range from a fraction of a μsec to ms. (319)

A-D Converters Use Modular Construction

NAVIGATION COMPUTER CORP., Valley Forge Industrial Park, Norristown, Pa., announces the 2200 series of analog-to-digital converters. They have an absolute accuracy of 0.05



Complex computer boards wired automatically by Wire-Wrap® machines

2480 wires and 4960 connections are contained in this complicated back panel—automatically wired by a Gardner-Denver "Wire-Wrap" machine.

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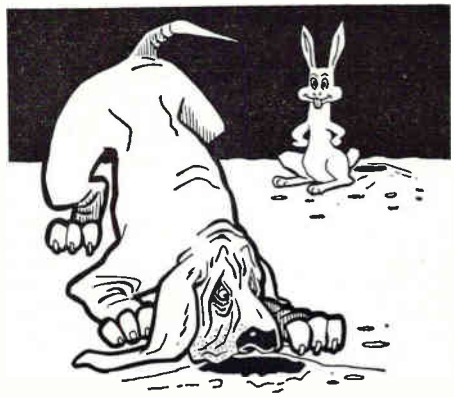
Gardner-Denver Company, Gardner Expressway, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario



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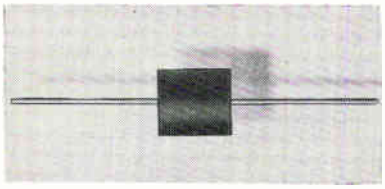
CIRCLE 209 ON READER SERVICE CARD

percent, and a conversion rate of 8,000 samples per sec. Models are available for unipolar or bipolar inputs, and come with either binary or binary-coded-decimal outputs. Prices start at $2,775.
CIRCLE 320, READER SERVICE CARD



Solid-State Rectifier Has Axial Leads

SOLITRON DEVICES, INC., 500 Livingston St., Norwood, N. J. Solid state rectifier is designed to deliver 3 amp without heat sink at voltages up to 1,200 v. Unit has an hermetically sealed insulated body which has been transfer molded by a process that utilizes thermoset silicon quartz-filled material. Electrical ratings include 25 μa leakage at 25 C, 325 amp single cycle surge and 1.0 voltage drop. (321)

Ceramic Capacitors Feature Miniature Size

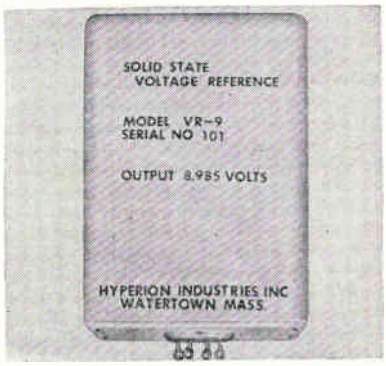
AEROVOX CORP., New Bedford, Mass. Cerol capacitors are rolled ceramic capacitors in the high capacitance range of paper and plastic film dielectrics but are considerably smaller in size. Designed for general applications in by-pass coupling, filtering and blocking circuits, the capacitors are highly advantageous in applications where a low series resistance at high frequencies is required. (322)

Variable Time Delay Features Gated SCR

ADC ELECTRONICS, 1205 S. Santa Fe Ave., Compton, Calif. Features an RC unijunction transistor timing circuit to gate a scr rated at ½ amp at 25 C. Delay range of 1 to 120 sec

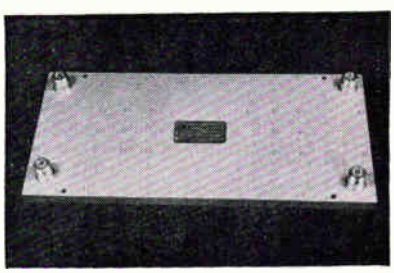
can be obtained by varying an external resistor. Ambient temperature range is −55 C to +85 C. Fully encapsulated to conform with MIL-E-5272. Has reset time of 20 millisec max and life in excess of 10 million cycles.

CIRCLE 323, READER SERVICE CARD



Voltage Reference Uses Standard Cell

HYPERION INDUSTRIES, INC., Watertown, Mass. Model VR-9 solid state standard cell provides an output voltage of 9 v d-c ± 5 percent, factory-calibrated to ±5 mv for zero current drain, and marked accordingly. Standard units drive loads up to 1 ma; custom units drive loads up to 20 ma. Input voltage is 100 to 130 v a-c, 50 to 1,200 cps. Temperature stability is 25 μv/deg C, −55 C to +85 C. (324)



Compact Hybrids Made of Stripline

ELECTRONIC SPECIALTY CO., 5121 San Fernando Road, Los Angeles 39, Calif. Series CH-1212 180-degree hybrids are constructed in stripline and furnished with type N coaxial terminals. Standard units are immediately available in octave bandwidths throughout the spectrum from 60 Mc to 4,000 Mc. Power handling is 300 w c-w. Phase deviation over an octave is less than ±10 deg. Minimum isolation is 20 db. (325)

PRODUCT BRIEFS

TEMPERATURE CONTROLLER thermistor based. Yellow Springs Instrument Co., Inc., Box 106, Yellow Springs, O. (326)

CHASSIS SLIDES extruded aluminum. Chassis-Trak, Inc., 525 S. Webster, Indianapolis, Ind. (327)

SNUBBER DISPENSER for precut wire assembly. Highland Products, Inc., Dover, N. J. (328)

SILVER-ZINC MISSILE BATTERY arc-shaped. Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y. (329)

ULTRASONIC CLEANER has 75 gallon capacity. Ultrasonic Systems, Inc., POB 11085, Palo Alto, Calif. (330)

PROCESS CONTROL COMPUTERS high-speed. Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa. (331)

CRYOGENIC FLASK up to triple liquid gas holding times. Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas. (332)

SUBMINIATURE GERMANIUM DIODE for demodulator circuits. Telefunken GMBH, Presseabteilung, Ernst-Reuter-Platz 7, Berlin-Charlottenburg 1, Germany. (333)

MAGNETIC SHIELDING CELL isolates large variety of components. Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. (334)

A-C REVERSING MOTOR with brake. U. S. Industries, Inc., 6312 Hollister Ave., Goleta, Calif. (335)

COINCIDENT CURRENT MEMORY 2 μsec. Indiana General Corp., Electronics division, Keasbey, N. J. (336)

EVENT RECORDER four-channel. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. (337)

ALUMINA OR BERYLLIA PARTS gold coated. Alloys Unlimited, Inc., 21-01 43rd Ave., Long Island City 1, N. Y. (338)

D-C VOLTMETER servo-operated. F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif. (339)

RADAR POWER SUPPLY low-ripple. General Electric Co., Schenectady 5, N. Y. (340)

PRECISION POT MODULE 4-gang unit. Technology Instrument Corp. of California, 850 Lawrence Drive, Newbury Park, Calif. (341)

HIGH CURRENT SUPPLIES programmable. Kepco Inc., 131-38 Sanford Ave., Flushing 52, N. Y. (342)

POWER TRANSFORMERS miniature, 400 cps. Electro Windings and Components, Inc., 239 Hollywood Ave., Hillside, N. J. (343)

MICROMINIATURE COAX CONNECTORS cut cable assembly time. DuTron

Corp., 777 W. 17th St., Costa Mesa, Calif. (344)

AUTOTRANSFORMER cased 5-amp unit. General Radio Co., West Concord, Mass. (345)

ELECTROMETER and power supply combination. Gyra Electronics Corp., Washington & Elm Sts., LaGrange, Ill. (346)

H-PLANE R-F SWITCHES excellent isolation. The Douglas Research Corp., Mt. Vernon, N. Y. (347)

SWEEPING OSCILLATORS plug-in type. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J. (348)

MILLIVOLTMETER low-cost, full four-digit. Non-Linear Systems, Inc., Del Mar, Calif. (349)

FREQUENCY MULTIPLIER phase-coherent. Resdel Eng. Corp., 330 S. Fair Oaks Ave., Pasadena, Calif. (350)

SMALL GAS DRYER for tactical missiles. Lear Inst. Div., 110 Ionia Ave., N.W., Grand Rapids 2, Mich. (351)

POWER RHEOSTAT miniaturized. Tru-Ohm Products, 3426 W. Diversey Ave., Chicago 47, Ill. (352)

ULTRASONIC DEBURRER cuts production costs. Powertron Ultrasonics Corp., Fairchild Ave., Expressway Ind. Park, Plainview, L. I., N. Y. (353)

CONNECTORS for plug-in circuit modules. U.S. Dielectric Inc., 181 Greenwood St., Worcester, Mass. (354)

STEP REFLECTORS for optical maser systems. Perkins-Elmer Corp., Norwalk, Conn. (355)

DATA PROCESSING SYSTEMS four new models. Burroughs Corp., 219 Park Ave., South, N. Y. 3, N. Y. (356)

POWER SUPPLIES close regulation, low ripple. Acopian Technical Co., 927 Spruce St., Easton, Pa. (357)

SENSITIVE VTVM chopper stabilized. Dynatran Electronics Corp., 178 Herricks Rd., Mineola, N. Y. (358)

TAPER PIN P-C CONNECTORS dual-tube. Viking Ind., Inc., 21343 Roscoe Blvd., Canoga Park, Calif. (359)

PROGRAMMER for sequential control. Granger Associates, 974 Commercial St., Palo Alto, Calif. (360)

FLOW COMPUTER provides instant measurement. Daniel Orfice Fitting Co., 9720 Katy Road, Houston, Texas. (361)

CIRCUIT BUILDERS BREADBOARD small size. Circuit Structures Lab, P.O. Box 36, Laguna Beach, Calif. (362)

PHOTOELECTRIC CONTROL UNITS transistorized. Melpar, Inc., 3000 Arlington Boulevard, Falls Church, Va. (363)

HEADSET-MICROPHONE ASSEMBLY for adverse noise environments. Roanwell Corp., 180 Varick St., New York 14, N. Y. (364)

Literature of the Week

DIGITAL CIRCUIT CARDS Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. Catalog G42a covers G series 10 Mpps digital circuit card modules. (365)

METAL FILM RESISTORS Daven Division of General Mills, Inc., Livingston, N. J. A catalog and price list on metal film resistors. (366)

PRODUCT MARKING Markem Machine Co., Keene, N. H. Catalog describes methods, machines, type, and ink for identifying all types of electronic products. (367)

NUVISTOR TUBES Radio Corp. of America, Harrison, N. J. Temperature ratings and thermal considerations for Nuvistor tubes. *Application Note* AN-194. (368)

COMMAND-DESTRUCT ANTENNA Andrew Corp., P.O. Box 807, Chicago 42, Ill. Bulletin 9734 covers a high gain ground-to-air command-destruct antenna. (369)

TRANSISTOR AND DIODE TESTER Texas Instruments Inc., 3609 Buffalo Speedway, P.O. Box 66027, Houston 6, Texas. Bulletin A-704 illustrates and describes model 654 fast go/no-go transistor/diode tester. (370)

BROADBAND ROTATING JOINTS De-Mornay-Bonardi, 780 South Arroyo Parkway, Pasadena, Calif. Brochure covers a line of ultramicrowave and microwave waveguide broadband rotating joints. (371)

LEAK DETECTOR Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Bulletin describes type 24-120A Mass-spectrometer leak detector. (372)

TAPE SPOOLER Electronic Engineering Co. of California, Box 58, Santa Ana, Calif. Data sheet describes the TS-405 tape spooler which winds at speeds up to 50 ips. (373)

TERMINAL BLOCKS Burndy Corp., Norwalk, Conn. Catalog contains technical description of miniature and standard size terminal block construction. (374)

ROSIN FLUX REMOVER Supracote Development Laboratory, 11 First St., Bloomingdale, N. J. Illustrated bulletin describes Reflux safety solvent for fast, efficient removal of rosin flux residues, and general metal cleaning. (375)

SIGNAL GENERATOR Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa. Bulletin 711A-1 describes a variable-phase, l-f signal generator for use in frequency response analyses. (376)

ULTRASONIC DRILLS Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., has issued bulletin V7d on its Glennite Hi-T ultrasonic impact drills. (377)

Foxboro Erecting Research Center

START of construction for a $700,000 research center at Foxboro, Mass., has been announced by the Foxboro Co. The building will house the firm's expanding R & D activities, facilitating greater emphasis on advanced instrument engineering for the process industries, according to W. E. Vannah, director of research. Completion is scheduled for January, 1963.

The three-story structure will bring the total research facilities to nearly 50,000 square feet and enlarge the plant area at Foxboro, Mass., to 611,000 square feet.

The first floor will include an auditorium and a simulation laboratory with analog and digital equipment for the study of systems and product design problems. The second floor will house laboratories, offices and conference rooms. The third floor will be an information center, with library, patent files and study rooms. The basement will be largely devoted to heavy processing equipment and test gear needed for application research and evaluation projects.

The architectural theme is flexibility. Floor plans can be varied as research requirements change. The brick and steel building is designed in four-foot modules. Walls are easily moved and utilities can be brought up in any desired location from a below-stairs walkway.

North Atlantic Promotes Herman

SIDNEY HERMAN recently advanced from director of engineering to vice president of engineering for North Atlantic Industries, Inc., Plainview, N. Y.

Company is engaged in the design, development and manufacture of electronic test instruments, measuring instruments, control systems and instrument servos.

Western Scientific Opens Laboratory

OPENING of a commercial primary standards laboratory in Los Angeles, Calif., has been announced by Gordon S. Marshall, president of Marshall Industries, San Marino.

The laboratory will be operated by the Western Scientific Instrument Co., a subsidiary of Marshall Industries. Western Scientific specializes in the calibration, maintenance, and repair of electronic test equipment used in R&D, production-line testing and final testing. The laboratory equipment assures the accuracy of Western Scientific's testing devices in accordance with the measurements established by the National Bureau of Standards.

Belock Appoints Two Executives

JEREMY TAYLOR has been named executive assistant to the president and acting dirctor of programs at Belock Instrument Corp., College Point, N. Y. He was previously associated with Lockheed Missiles and Space Corp.

Arthur J. Minasy, formerly with Sperry Gyroscope Co., has been appointed vice president for operations in charge of production and engineering of Belock.

Greenwald Advances At Norden Division

PROMOTION of Martin H. Greenwald to assistant chief—radar and communications in the engineering department at United Aircraft Corporation's Norden division, Norwalk, Conn., is announced.

With Norden since 1955, Greenwald most recently has been responsible for the design and development of video, data processing, and display equipment for radar systems.

Appoint Bernier ASTIA Director

CHARLES L. BERNIER was recently appointed director of the Armed Services Technical Information Agency, which has its headquarters at Arlington Hall Station, Va.

Bernier has been serving as tech-

NEW

all solid-state plug-in

DECADE COUNTER MODULE

PRICE COMPLETE

from **$85.00** *each*

including ultra long-life wide-angle 1" Nixie tube

The new Anadex plug-in module features an entirely new circuit that is simple, reliable, and rugged. These modules can be interconnected to perform totalizing and counting operations from 0 to 100 KC.

- Measures 1¼" wide x 1¾" high x 6½"
- Low current consumption—only 10 ma per decade
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electronics

Editorial Opportunity

IT DOESN'T HAPPEN OFTEN, but **electronics**, "bible of the industry" and a McGraw-Hill publication, has an opening for an Assistant Editor.

Ideally, the man we are looking for and to whom a post on our New York staff could be a long-term challenge, would have an electrical engineering degree or technical equivalent, practical experience in our field and a demonstrated aptitude for editing, writing, reporting. He probably lives somewhere in the metropolitan area and therefore would have no relocation problem.

Write **The Editor, electronics, 330 W. 42nd St., New York 36,** stating experience, aspirations and past earnings. Mark the envelope "Confidential" and it will be kept that way.

IN DIGITAL DATA COMMUNICATIONS . . .

DD LINE = RELIABILTY + FLEXIBILITY + LOW COST

The need for reliable and flexible low-cost data communications equipment has led to the design and development of the Rixon **DD Line. DD** is the packaging of basic data communications system components into functional units. Now the system designers can build a system from **DD** modules to meet their exact requirements in either medium—wire line or HF radio circuits. Available now are modulators, demodulators, clocks, phase resolvers, delay equalizers, and serial-to-parallel converters, just to mention a few—at bit rates from 600 to 4800 bps.

Advantage? Reliability and complete flexibility at low cost—a result of over five years experience with data transmission systems.

Availability? Now!!!

RIXON ELECTRONICS, INC.

2121 Industrial Parkway–Montgomery Industrial Park–Silver Spring, Maryland

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CIRCLE 95 ON READER SERVICE CARD

nical advisor to this agency, which as a central service of the Department of Defense, provides an interchange of technical information to serve engineers and scientists working on the nation's weapon systems and other priority projects.

Brown Accepts Wellington Post

APPOINTMENT of Robert C. Brown to the position of director of engineering of Wellington Electronics, Inc., Englewood, N. J., is announced.

He was formerly associated with Westinghouse Electric Corp., at the R&D center, Pittsburgh, Pa.

Acoustica Associates Elevates Knox

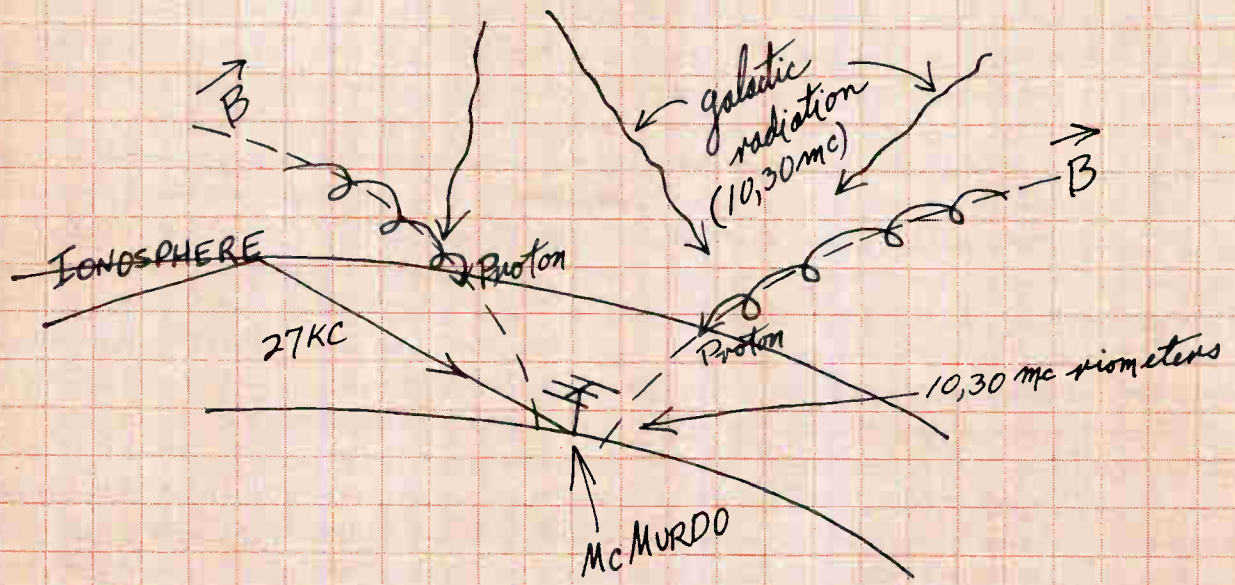
CAMERON KNOX, corporate director of research for Acoustica Associates, Inc., Los Angeles, Calif., has been elected a vice president.

A specialist in oceanography, Knox has been with Acoustica since April, 1961.

Set Up Engineering Services Company

CHARLES H. STANDISH has announced the formation of a new

Of interest to engineers and scientists



ANTARCTIC RIOMETER PROGRAM

...one of more than 500 R&D programs under way at Douglas

This Douglas program is being conducted in cooperation with the National Science Foundation with these objectives:

To investigate the apparent existence of a world-wide semi-annual variation in the occurrence of polar cap absorption events; to determine the frequency and time-intensity of solar cosmic ray events; to correlate North and South Pole riometer measurements and study differences in the polar ionospheres; to study the effects of radiation on ionospheric parameters.

The program will continue through the next solar sunspot maximum in 1969. Among other aspects, it will be useful in setting up criteria for the protection of astronauts from radiation.

Of career interest to engineers and scientists Douglas has entered into a period of greatly expanded activity in research programs like the one above and huge development projects like Skybolt, Saturn IV, Rebound, and others. Outstanding positions are now open in practically all scientific and engineering fields related to missile systems and space exploration.

Scholarships and financial assistance are available to continue your studies in such nearby universities as U.C.L.A., Southern California and Cal Tech.

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company, Research for Industry, Inc., in Cleveland, O. This firm will certify the services of technically skilled personnel, which it will contract to industry and government.

Standish is joined in the new organization by Jack M. Stewart, who will be president and general manager. Stewart will continue to operate his management consulting and engineering firm, Industrial Technological Associates, Inc. Jay C. Standish will be vice president of the new company.

PEOPLE IN BRIEF

John P. Nash advances to v-p of Lockheed Missiles & Space Co. **Harold S. Pike, Jr.,** promoted to post of asst. to the president of Nytronics, Inc. **Ira M. Rosenthal** leaves Minneapolis-Honeywell to join Oak Mfg. Co. as chief industrial engineer. Booz, Allen Applied Research Inc. ups **John R. Shirley** to v-p. **Barry Coetsee,** previously with ITT-Kellogg, appointed an electronic engineer at Communicom, div. of Chaskin-Dimmick Corp. **James H. Schaefer,** formerly with Amphenol-Borg Electronic Corp., named v-p and g-m of Viking Industries, Inc. **Marvin Rubinstein,** from the Garrett Corp. to Electro-Optical Systems, Inc., as supervisor of the Computer facility. **Rocco Tamburello** moves up to quality control mgr. for KinTel div., Cohu Electronics, Inc. Mallory Semiconductor Co. elevates **Ronald McWilliams** to chief engineer. **John W. Smith,** ex-Gates Radio, now mgr. of engineering for Vitro Electronics. Western Scientific Instrument Co., Inc., promotes **Martin L. Lundquist** to mgr., quality control. **Paul I. Richards,** of Technical Operations, Inc., appointed a corporate fellow of the firm. **Frank G. Daveler,** formerly with International Resistance Co., named v-p and g-m of all Eastern operations of Crescent Engineering & Research Co. **Robert M. Mitori** leaves McDonnell Aircraft Co. to become a senior staff engineer with Rixon Electronics Inc. **Bernard Epstein,** ex-Electrosolids Corp., joins Endevco Corp. as technical service engineer on piezoelectric transducers.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

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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: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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COLLINS RADIO COMPANY Dallas, Texas	18	2
DOUGLAS AIRCRAFT CO. Missile and Space Systems Division Santa Monica, California	97	3
GENERAL DYNAMICS/ELECTRONICS Div. of General Dynamics Corp. Rochester, New York	102	4
INTERNATIONAL BUSINESS MACHINES CORP. Space Guidance Center Owego, New York	101	5
LOCKHEED MISSILES & SPACE CO. Div. of Lockheed Aircraft Corp. Sunnyvale, California	70, 71	6
McDONNELL St. Louis, Missouri	147*	7
MELPAR, INC. Sub. of Westinghouse Air Brake Co. Falls Church, Virginia	101	8
MICROWAVE SERVICES INTERNATIONAL, INC. Denville, New Jersey	145*	9
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Washington, D. C.	146*	10
NORTHROP CORP. Norair Division Hawthorne, California	135*	11
NORTHROP CORP. Space Laboratories Hawthorne, California	137*	12
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	103	13
REPUBLIC AVIATION CORPORATION Missile Systems Division Mineola, L.I., New York	145*	14

(CONTINUED ON PAGE 104)

(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) 7/6/62

☐ 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

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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.

Positions Vacant
Positions Wanted
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Civil Service Opportunities
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Advanced circuit physicist for creative research in function synthesis and quantum mechanics, including material in solid, liquid and gaseous state.
Ph.D. required.

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Employment Manager

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ELECTRONIC RECONNAISSANCE SYSTEMS

SENIOR ANTENNA ENGINEER

BSEE with 3 to 4 years experience on ground-based antennas and radomes. Knowledge of antenna test data reduction and analysis required. Frequency spectrum VHF and up. To design systems antenna configurations, analyze existing designs, reduce and analyze antenna test data and make recommendations for necessary re-design.

SENIOR RELIABILITY ENGINEER

BSEE with 3 to 5 years experience. Must be systems oriented in the reliability field, preferably with some operations research background. Will be responsible for designing and implementing a reliability program on a large electronic system and will make the necessary data reduction involved in such a program.

SENIOR DESIGN ENGINEERS

BS with 8 years experience, of which 5 must have been in design in two or more of the following: digital, RF, pulse, audio, CRT, photorecorders, magnetic recorders, pulse multiplex and frequency multiplex. To assist in evaluation of complex electronic reconnaissance systems.

DESIGN ENGINEERS

BS with 3 to 5 years experience in RF and microwave receivers, digital display circuits, data handling and CRT displays including storage tube circuits. To assist in evaluation of complex electronic reconnaissance systems.

HYDROACOUSTICS

SENIOR SONICS ENGINEER

BS or MS in ME or Physics with at least 5 years experience in Industrial Sonics. Should have background in sonic cleaning, processing and impact drilling plus a basic knowledge of acoustics, general physics and chemistry.

TEST EQUIPMENT & INSTALLATIONS

PROJECT ENGINEERS

To supervise design and integration of test stations. Knowledge should include 1 or more of the following areas: flight control systems, radar indicators, HF-VHF navigation and communication equipment, microwave equipment, antenna systems and ECM. Should be familiar with all types of testing techniques and equipment associated with particular areas of interest. BSEE.

SENIOR DESIGN ENGINEERS

BSEE with thorough background in one of the following: microwave signal generators and receivers; low frequency signal generators, HF-UHF signal generators, digital and pulse circuits, AGE Systems.

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Requires thorough background in the electronics industry in preparation of military handbooks and manuals or in engineering proposals.

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Engineers at all levels, experienced in design of:

RECEIVERS — Panoramic, signal seeking, manually tuned. **DISPLAYS** — Digital, CRT amplitude-time, storage tube direction finder, panadapter, high-speed pulse recording. **REMOTE CONTROLS** — Antenna servo followers, antenna and receiver remote positioning and tuning. **DATA HANDLING** — Transistorized timer-programmer, on-line printer, automatic signal analyser, magnetic tape analysis equipment. **EQUIPMENT INTEGRATION** — Console and rack design, sub-system layout and blackbox compatibility, design standardization, sub-system analysis, man-machine optimum design, blackbox sub-system specifications. **RADIO FREQUENCY INTERFERENCE CONTROL** — Analysis of equipment RFI problems, establishment of design procedures, testing to MIL-I-26600, reports, vendor liaison and direction.

For further information on how YOU can contribute to one of the various programs now in progress, send a complete resume to Mr. M. J. Downey, Dept. 22.

GENERAL DYNAMICS | ELECTRONICS ROCHESTER

AN EQUAL OPPORTUNITY EMPLOYER

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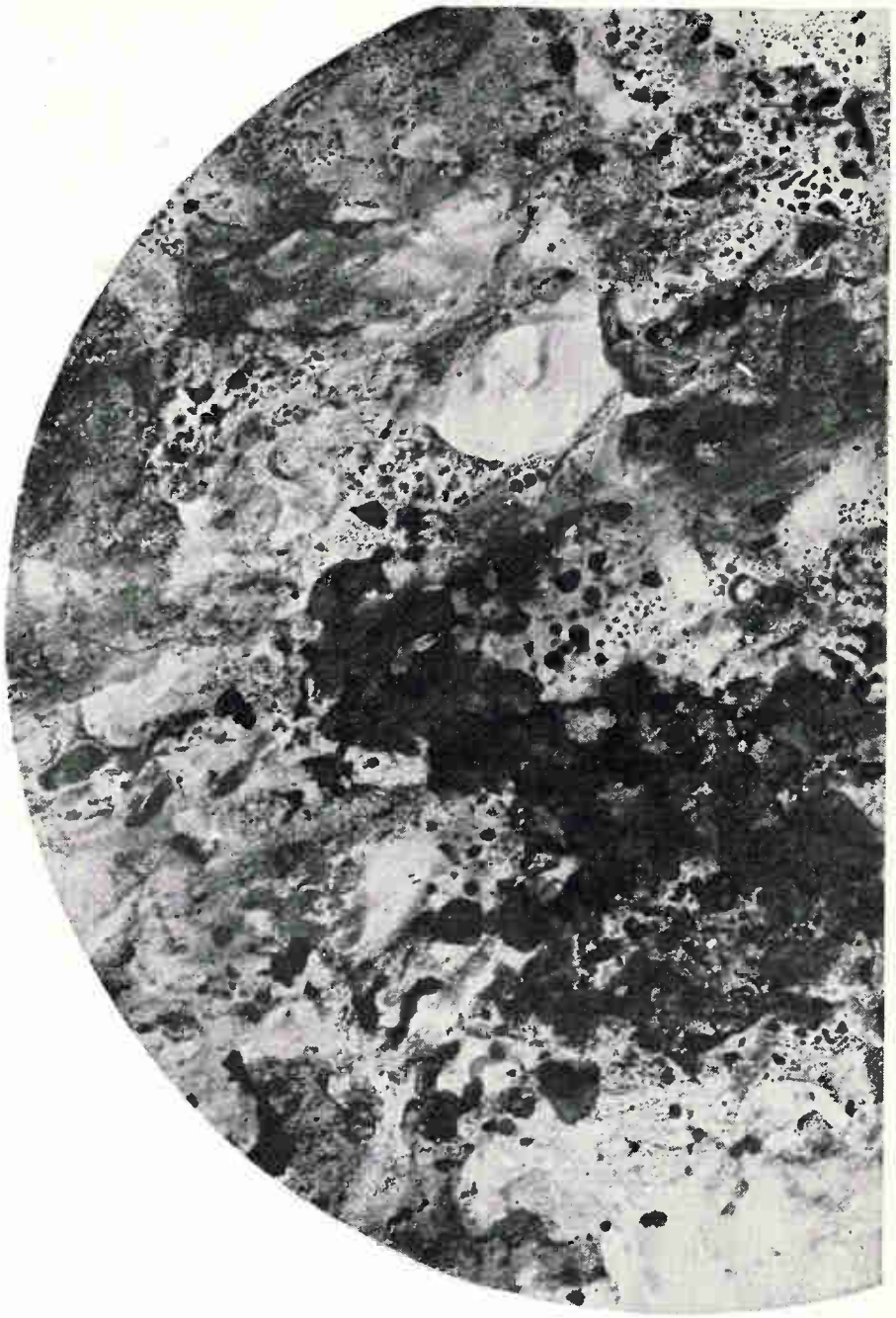

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IS TOMORROW'S MYSTERY. What we know today is insignificant alongside what we will know tomorrow, and Philco Western Development Laboratories' advanced technology leads the way to better solutions for bigger problems . . . and to your career. With its space age achievement a matter of record in some of the Nation's most important satellite programs, Philco WDL extends a penetrating probe into the mysteries of tomorrow's universe: Cosmic ray and ruby laser optics, solid state microwave electronics, microwave miniaturization, signal detection techniques, deep-space communications. These are advanced fields being explored today at Philco WDL. Your career there can be as successful as your adventuring spirit. Tomorrow's space age problem is today's task at WDL.

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Highly skilled electronic instrument technicians to work with electronic engineers in the development, installation and maintenance of electronic systems. Digital data handling, transistorized pulse height analyzers, analog and digital computer systems are only a few examples.

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Employee Benefit Plans
An Equal Opportunity Employer

Send detailed resume to:

Central Employment Office
UNION CARBIDE NUCLEAR COMPANY
Post Office Box M Oak Ridge, Tennessee

Engineering or Science Graduates
to be trained as
INSTRUMENT SALES ENGINEERS
with
The Bristol Company

Leading manufacturer of automation equipment and control systems requires men, preferably 25 to 35 years old, to sell high quality, nationally accepted products to wide variety of industrial markets.

Openings in various areas of the country. Successful applicants take comprehensive three-months course at headquarters. Salary and expenses

All replies confidential; every inquiry answered.

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

The Bristol Company
Waterbury 20, Conn.

POSITIONS VACANT

Electronic Engineers for permanent positions with Federal Communications Commission, Washington, D. C., GS-12, $8,955 to GS-13, $10,635. Must be graduate engineers with good knowledge of problems involved in the area of space communications. Government will pay expenses for transportation of employee, his family, and household goods to Washington. Attractive fringe benefits include retirement, life and health insurance, automatic pay increases. Good opportunity to enter government career service. Reply to Personnel Officer, Federal Communications Commission, Washington 25, D. C.

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electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 100)

SCOPE PROFESSIONAL PLACEMENT CENTER Waltham, Massachusetts	145*	15
SPACE TECHNOLOGY LABORATORIES INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	26*	16
SPERRY GYROSCOPE COMPANY Div. of Sperry Rand Corp. Great Neck, L.I., New York	147*	17
UNION CARBIDE NUCLEAR COMPANY Oak Ridge, Tennessee	104	18

*These advertisements appeared in the 6/29/62 issue.

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.

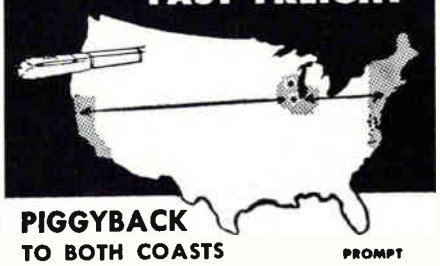
UNDISPLAYED RATE

$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).

LIFSCHULTZ FAST FREIGHT



PIGGYBACK
TO BOTH COASTS
TRUCKLOAD RATES
TO BOTH COASTS
PROMPT DAILY PICKUP and DELIVERY
•*We welcome your inquiry.*

FASTEST TO BOTH COASTS!

CIRCLE 950 ON READER SERVICE CARD

FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons. IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.
PRICES AT A FRACTION OF ORIGINAL COST!
COMMUNICATIONS EQUIP CO.
343 CANAL ST., N. Y. 13, WO 6-4045
CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 951 ON READER SERVICE CARD

WEAK IN MATH?

Don't let inadequacy in mathematics hold you back. Now you can learn the basic math you must know to succeed as a technical man. Learn through Grantham Schools' unusual home study math course for technicians, engineers, and mechanics. Write for details today.
Write to : Dept. 2E.
GRANTHAM SCHOOLS, INC.
1505 N. Western Ave. Los Angeles 27, Calif.

CIRCLE 952 ON READER SERVICE CARD

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

Method for measuring an engineer...

What's his technical publication ?

When an engineer pays for a technical publication, it's a safe bet that that is the one he respects most.

He makes it his business to read **electronics**. It keeps him well informed of up-to-the-minute events and developments in the electronics industry and the technology to which he contributes his experience.

Where your recruitment program calls for engineers and other technical people of this calibre, you can reach them in the EMPLOYMENT OPPORTUNITIES section of:

electronics
A McGRAW-HILL PUBLICATION
CLASSIFIED ADVERTISING DIVISION
POST OFFICE BOX 12 NEW YORK 36, NEW YORK

INDEX TO ADVERTISERS

Audited Paid Circulation

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

■

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

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Audited Paid Circulation

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Advertising Sales Manager

R. S. QUINT:
Assistant Publisher Buyers' Guide and Business Manager
FRED STEWART:
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Market Services Manager

RICHARD J. TOMLINSON:
Production Manager
GEORGE E. POMEROY:
Classified Manager
HUGH J. QUINN:
Circulation Manager

ADVERTISING REPRESENTATIVES

NEW YORK (36):
Donald H. Miller, Henry M. Shaw, George F. Werner
500 Fifth Avenue, LO-4-3000 (area code 212)

BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copley Square, Congress 2-1160 (area code 617)

PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOcust 8-4330 (area code 215)

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)

SAN FRANCISCO (11):
R. C. Alcorn
255 California Street, Douglas 2-4600 (area code 415)

LOS ANGELES (17):
Peter S. Carberry, Ashley P. Hartman
1125 W. 6th St., Huntley 2-5450 (area code 213)

DENVER (2):
J. W. Patten
Tower Bldg., 1700 Broadway, Alpine 5-2981 (area code 303)

ATLANTA (9):
Michael H. Miller, Robert C. Johnson
1375 Peachtree St. N.E., Trinity 5-0523 (area code 404)

HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Holcomb Blvd., Riverside 8-1280 (area code 713)

DALLAS (1):
Frank Le Beau
The Vaughn Bldg., 1712 Commerce St.
Riverside 7-9721 (area code 214)

LONDON W1:
Edwin S. Murphy Jr.
34 Dover St.

FRANKFURT/Main:
Matthée Herfurth
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

this is the Brush Mark II...

anyone can plug it in put it in writing anywhere

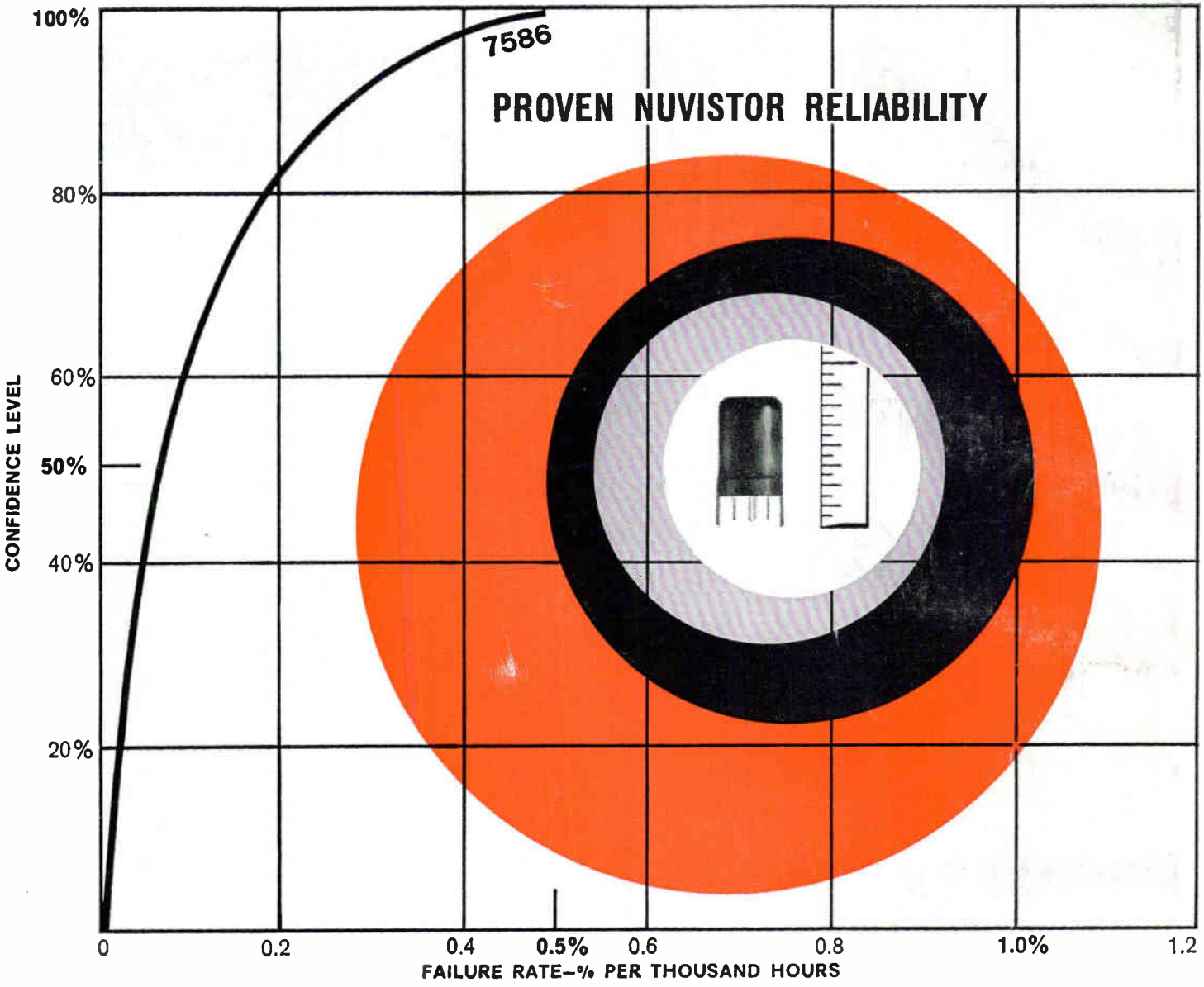
There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

brush INSTRUMENTS

DIVISION OF CLEVITE CORPORATION

37TH AND PERKINS CLEVELAND 14, OHIO

CIRCLE 901 READERS SERVICE CARD



RCA-7586 FAILURE RATE IS:

0.36% OR LESS PER THOUSAND HOURS WITH A 95% CONFIDENCE LEVEL

...and at a 50% confidence level, the failure rate is only 0.084% or less per 1,000 hours. These extremely low failure rates shown with corresponding confidence levels on the chart above, are based on more than 1,000,000 tube hours of *actual* life testing. Many of the life tests have been run beyond 5000 hours with no sustained downward trend in transconductance observable in the distribution.

This data indicates you can be 95% sure that RCA-7586 nuvistor triodes, operated under conditions equivalent to those described, would have less than 4 failures out of each 100 tubes after 10,000 hours of operation.

These life test results demonstrate conclusively the *extra* reliability the tiny nuvistor tube brings to your electronic systems.

Tests were conducted under two sets of field conditions as shown:

NUVISTOR LIFE TEST CONDITIONS

	Test Conditions #1	*Test Conditions* #2
Heater Volts	6.3	6.3
Heater-Cathode Volts	100	0
Plate Volts	100	—
Plate-Supply Volts	—	75
Grid Volts	−1.85	—
Cathode Resistor—Ohms	—	100
Grid-Circuit Resistance—Megohm	0.5	0.5
Metal-Shell Temperature—°C	150	150
Plate Dissipation—Watts	1	0.75

Start now to give your circuits the extra advantage of nuvistor reliability and performance. For technical data on the 7586, get in touch with your RCA Field Representative or write Commercial Engineering, Section G-19-DE-1, RCA Electron Tube Division, Harrison, N.J.

FIELD OFFICES:

EAST: 744 Broad St., Newark 2, New Jersey
HUmboldt 5-3900

MIDWEST: Suite 1154, Merchandise Mart Plaza
Chicago 54, Illinois
WHitehall 4-2900

WEST: 6801 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

1838 El Camino Real, Burlingame, Calif.
OXford 7-1620

The Most Trusted Name in Electronics