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electronics

AIR TRAFFIC CONTROLLERS *follow flight path on radar display.*

But will they be able to cope with tomorrow's traffic load?

First article of a three-part series on air traffic control, p 37

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December 7, 1962

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CONTENTS continued

DEPARTMENTS

Air Traffic Control: A Challenge

A GOOD WAY to avoid arguments is to duck out of conversations that involve religion, politics and air traffic control. All three are loaded.

Common denominator for these phenomena is the complexity inherent in each, the variety of legitimate viewpoints that are possible and the particular ax one has to grind.

Just about everyone agrees that the Federal Aviation Agency's air traffic system is complex —even those who use more colorful words to describe it. It is vast, almost unwieldy, and has the task of doing a needed job and also trying to satisfy a variety of groups with conflicting interests.

Air carriers with expensive airborne equipment would like more positive control by the air traffic control system. Sunday pilots in small planes lobby to safeguard the American ideal of "freedom of the air." The military has an interest in any decisions FAA makes—as do the electronics industry, foreign air carriers, company-plane owners and the frightened, irate air traveler who survives a near miss. Congress is besieged by delegates from all these aggregations—often with the unpleasant reminder that they vote.

In juggling these factors to come up with a better solution there is always another consideration to keep in mind—any and every decision may mean life or death. This is one reason that progress seems to crawl rather than to walk.

Critics often say that FAA is top heavy with administrators, that the system of political appointees causes some programs to be arbitrarily thrown out and new ones initiated, that Congress has far too much authority to approve or veto the introduction of new air traffic control techniques.

There is probably some truth in all of these objections. Rectification may, or may not, come soon. But there is hope—and a challenge to the electronics industry—in the new, long-range design that is planned to carry the system through 1975. The concept seems logical and orderly, and it is hoped that the next administrator will leave it alone.

The details have not yet been worked out. They must be largely provided by the electronics industry. Many frustrated contractors complain, meanwhile, that FAA's decision-making is slow. This problem may never be completely cleared up. But decision-making will definitely have to speed up to cope with the increasing urgency of providing safe airspace for the growing fleet of planes.

TERMINAL AREA *problems run through this simulator result in specs for hardware*

The FAA budget has already been increased, and will probably be upped again to pay for the new system—the half billion dollars FAA plans to spend by 1975 may not be enough.

Electronic equipment manufacturers who have drifted away from FAA projects would be well advised to look at the new ones.

The challenge is there, and so is the market.

Coming In Our December 14 Issue

PROJECTION TV. We broke the news a few weeks ago on the low-cost projection tv system developed by Harries Electronics Corp. (p 7, Nov. 23). Then we followed up with Harries' views on how the development could affect the tv market (p 24, Nov. 30). Next week? A technical report on the system, authored by the inventor, J. H. Owen Harries.

Next week's issue will be in your mailbox just about the time Mariner II is passing Venus. While you listen to the news broadcasts on what Mariner sees, you can also read our article on the instrumentation that will be probing the planet's blanket of clouds.

The December 14 issue will also carry the second article in our series on air traffic control, a report on a 10-nanosecond computer amplifier, and an article on how to plot tunnel-diode switching waveforms.

COMMENT

Filter Design

The filter considered by W. J. Kerwin in his article, Simplified Low-Pass Filter Design (p 52, Sept. 7, 1962), is the third-order filter described by M. Dishal (Two New Equations For the Design of Filters, *Electrical Communication*, Vol. 30, No. 4, Dec. 1953) as "Taylor-Chebyshev" and shown by him to be represented by

$$\left|\frac{V_p}{V}\right|^2 = 1 + \frac{\left|\frac{V_p}{V_\beta}\right|^2 - 1}{\cosh^2\left(n \cosh^{-1} \frac{\omega_\beta}{\omega}\right)}$$

where V_p is the output voltage at the frequency where it is maximum and V is the output voltage at any other frequency. V_β is the output voltage at the peak in the stop band, and ω_β is the frequency below ω_∞ where this attenuation is also reached.

The solution for the element values and the ratios of the special frequencies arising are expressed in terms of the parameters

$$S = \sinh\left[\tfrac{1}{3}\sinh^{-1}\left(\left|\frac{V_p}{V_\beta}\right|^2 - 1\right)^{1/2}\right]$$

$$C^2 = 1 + S^2$$
$$C_o = 1/\omega_\beta R$$
$$L_o = R/\omega_\beta$$

For the open-circuit filter we have

$$C_1 = \frac{4S^2 - 3}{8S} \cdot C_o$$

$$L_2 = \frac{16S^3}{9(S^2 + \frac{1}{4})} \cdot L_o \qquad C_2 \text{ tunes } L_2 \text{ to } \omega_\infty = 1.155\,\omega_\beta$$

$$C_3 = \frac{12S^3 + 3}{8S} \cdot C_o$$

For the symmetrically terminated filter

$$C_1 = C_3 = S \cdot C_o$$

$$L_2 = \frac{8S}{3} \cdot L_o$$

$$C_2 = \frac{9}{32S} \cdot C_o$$

In each case we have $\omega_\beta = C \cdot \omega_3$, $\omega_r = 1.155\,\omega_\beta$, and $\omega_m = 2\,\omega_\beta$.

Typical values for the parameters C and S for values of V_p/V_β, expressed in decibels, are given in the following table

V_p/V_β in db	S	C
10	0.644	1.189
20	1.172	1.540
30	1.866	2.117
40	2.838	3.009
50	4.234	4.350

Similar explicit formulae have been obtained for the fifth-order filter with two separate frequencies of infinite attenuation, and numerical results for any order can be obtained using Dishal's results.

Reference to this and other works on Modern Network Theory will show the first paragraph of Kerwin's article to be far from the truth. The foundation of all modern filter designs is surely the relation between the attenuation and frequency parameters (see table above) followed by the response polynomial and component values, in that order.

M. R. NICHOLLS
Bruce Peebles and Co. Ltd.
Edinburgh, Scotland

The author replies:

Mr. Nicholls and I have corresponded regarding his comments and the equations given in his letter. He has worked out these solutions from Dishal's paper for the third-order case, and in a second letter [omitted for lack of space] he included the solutions for the fifth-order case.

I was, of course, not familiar with these equations, nor with the relation for the third-order case of $\omega_r = 1.155\,\omega_\beta$. Thus, my statement that ω_r is not immediately known is incorrect. The conventional method with which I was familiar, is given on page 292 of Storer ["Passive Network Synthesis," McGraw-Hill Book Company Inc., New York, N. Y., 1957], and was the basis of my statement in the first paragraph of my article.

In his article (Dec. 1953 as referenced by Mr. Nicholls), Dishal states: "It has not yet been possible to recognize the law of formation that would give a closed form solution for the network values." Mr. Nicholls has, however, worked out the solutions for the third-order and fifth-order cases as indicated in his two letters. This is indeed an excellent contribution to the practical application of filter theory.

WILLIAM J. KERWIN
Sunnyvale, California

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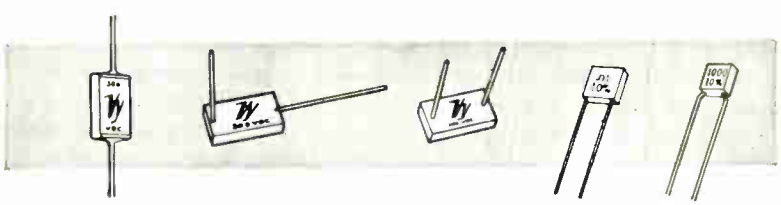

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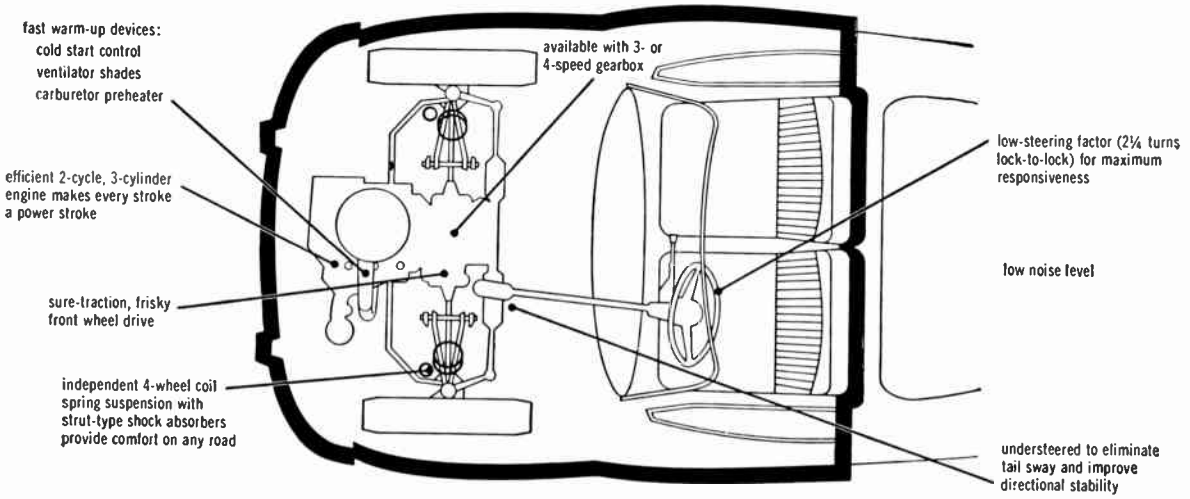

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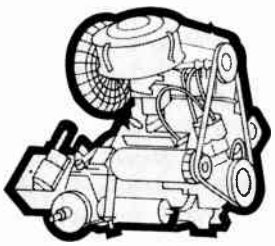

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ELECTRONICS NEWSLETTER

EIA Predicts $2 billion Sales Rise in 1963

SAN FRANCISCO—Electronics manufacturers can look forward to a $15.1 billion sales total next year, predicted Charles F. Horne, Electronic Industries Association president, at the EIA's Winter Conference last week. The predicted $2 billion rise over 1962 would mean an unbroken record of yearly sales increases since 1949.

The 1963 estimate, based on studies by EIA's Marketing Services division, includes $2.5 billion in consumer electronics products, $2.7 billion industrial, $9 billion military and almost $1 billion in replacement parts. Horne said that in the first 42 weeks of 1962, factory unit sales of radio, tv and phonographs were ahead of 1961 by 13, 14 and 10 percent, respectively.

A $500-million market for infrared products—a rise of more than 100 percent—by 1965 was predicted by Robert Manley, of Manley Associates. The New York consulting firm recently made a survey.

EIA to File Exceptions To $1.52 Minimum Wage

SAN FRANCISCO—The EIA's Walsh-Healey committee did recommend—as expected (p 7, Nov. 30)—that the Association's board of directors approve plans to file exceptions to the proposal for a $1.52 minimum wage under the Walsh-Healey Act. The board agreed on Thursday, but declined to detail the exceptions. The minimum proposed by the U.S. Labor Department for the electronic equipment industry is 12¢ higher than EIA recommended.

Air Force Enthusiastic About Optical Computer

AIR FORCE SYSTEMS COMMAND says there's been a breakthrough in optical computer research (p 30, Nov. 9). Rome Air Development Center will now concentrate on "build-up of a technological capacity which can result in the long sought optical computer."

A key to Air Force's optimism is Stanford Research Institute's neuristor logic scheme, based upon transmission of signals without attenuation. Lasering fibers can do this, cancelling transmission losses by slightly amplifying the signal.

RCA, another member of the research team, found out that lasering glass fibers will work in neuristor logic. RCA is working on how to use the fibers and the characteristics they need. American Optical Co. developed the glass.

An optical computer using light waves instead of electrical signals could be 10 or even 100 times faster and much smaller than present computers, says RADC.

AEC May Standardize Nuclear Power Sources

WASHINGTON—AEC is just now undertaking a study of all its Snap programs (nuclear power sources), indicated Glenn T. Seaborg, AEC chairman, at the Atomic Industrial Forum meeting last week (for earlier story, see p 26).

The study will serve to standardize Snap units on which AEC will concentrate development, define requirements of user agencies like NASA, Defense Department and Coast Guard, and determine funding for Snap in competition with other nuclear programs.

R. L. Kirk, Snap program manager, reported that through fiscal year 1962, AEC had spent $12 million on isotopic Snaps, $65 million on reactor Snaps and $21 million on the advanced Snap-50. These programs are getting $3 million, $45 million and $27 million, respectively, in the present fiscal 1963 budget.

AEC is spending $200 million a year for R&D in industry and private labs on the Snap and nuclear rocket programs.

Pulse Analyzer Shows Events in 3 Dimensions

WASHINGTON—Spectrum pulse analyzer that can provide two- and three-dimensional crt displays of nuclear events was shown here last week by Technical Measurement Corp.

With a coincidence-pair spectrometer logic unit, the basic system will analyze and display two sources of information related to the same event. A display control unit shows events along the third axis as degrees of spot intensity on the crt face. Address locations containing less than a selected number of counts can be blanked out, permitting examination of contours along the third axis.

The 1,024-channel analyzer has a sensitivity of 0.25 μsec. Robert Ghen, TMC president, said others capable of handling 10-nsec and

New Diode Laser Gives Tailor-Made Output

SYRACUSE, N. Y.—A new type of diode injection laser has been developed. Changing the chemical composition of the crystal makes the wavelength of its coherent output selectable over the approximate range of 6,200 to 8,400 angstroms. The laser is formed from a *p-n* junction of gallium arsenide-phosphide.

Successful operation of the device, reported this week in *Applied Physics Letters* by N. Holonyak, Jr., and S. F. Bevaccua, of General Electric's Semiconductor department, indicates that many ternary III-V compounds (systems consisting of different binary III-V compounds) can be used to form a wide variety of lasers with selectable characteristics.

GE engineers say that one of the early applications for the diode may be pumping ruby or neodymium glass rod lasers

30-nsec events will follow in a few months.

Full-Size Transistor Tv Being Developed in Japan

TOKYO—Two Japanese companies have revealed they are working on full-size transistor tv.

Nippon Columbia has an operating vhf prototype and is developing a 16-inch uhf set for use in Raytheon's Ratan harbor navigation system (p 76, May 18). The crt's electron gun has a low-current, 12-v filament.

Hitachi demonstrated a horizontal-sweep circuit for a 19-inch tube (19AEP4), using an experimental transistor. The transistor has a drift field in the base for increased collector-base breakdown (more than 250 v at 5 ma). Current gain is more than 30 at 10 amp.

Ocean-Bottom Sonar to Transmit Acoustically

IMPACT-LOCATING sonar system that Bendix-Pacific is building for Air Force will use acoustic data transmission to ships rather than cables to shore monitoring stations. The transmitting units, permanently placed on the ocean bottom, will be turned on and off from the ships.

The system will help missile-tracking ships pinpoint the locations at which nose cones and instrument packages splash into the ocean. Location accuracy will be a few miles in a distance of several hundred miles, Bendix said. The contract is for more than $1 million.

Three Guns in Chromatron Triple Its Brightness

NEW YORK—A three-gun Chromatron color-tv picture tube attained a highlight brightness of 300 foot-lamberts during a demonstration last week. The 23-inch tube, a modified Lawrence tube, was demonstrated by the Chromatic division of Paramount Pictures Corp.

Off-the-air color tv signals were used in the demonstration. By comparison, a single-gun Chromatron showed a brightness of about 100 foot-lamberts. In each case, ultor voltage was 25 Kv. Paramount has licensed Sony to make Chromatrons in Japan (p 7, Nov. 2) and is reported to be discussing agreements with American manufacturers.

Air Force Buying New Photo-Mapping System

KOLLSMAN INSTRUMENT CORP. has been selected by the Air Force as prime contractor for the AN/USQ-28 geodetic survey and photo mapping system. The contract is expected to have a potential of $50 million. Initial obligation is $3.4 million.

Kollsman is to build two prototype systems, with mapping cameras, inertial navigation system, data recorders and supporting electronics. The system is to be used in RC-135A jet aircraft.

Vocoders Will Put 10 Messages on 1 Channel

FALLS CHURCH, VA.—Voice compression system capable of transmitting up to 10 messages simultaneously over a single telephone channel is to be developed and produced for Army by Melpar under a $300,000 contract. Vocoders will convert spoken words to pulses and then reconvert them at the receiver to a voice approximating that of the speaker. The system is to operate at 1,200 bits a second.

New Tube Radios Warm Up Quickly

LOS ANGELES — Fast-warmup 30-watt and 60-watt mobile communicators were unveiled this week by RCA at the Vehicular Communications Conference. The radios use specially designed tubes in their final stage, making them ready for service less than a second after turn-on. The tubes, developed by Amperex, feature "harp" cathodes with multiple oxide-coated tungsten wires having essentially unipotential surfaces. Higher gain and transconductance is also claimed.

In Brief . . .

NIKE ZEUS' third stage was successfully test fired for the fourth time last week at Point Mugu. At Cape Canaveral, Skybolt failed its fifth test.

RFI EVALUATIONS made at Fort Huachuca by Bell Aerosystems are to be expanded under a new three-year, $14 million contract.

BECKMAN INSTRUMENTS and Vector Mfg. Co. have announced tentative agreement to merge. Vector, telemetry manufacturer, would become a Beckman subsidiary.

COMPANY to supply and service GE defense systems in Japan is being formed by Toshiba and GE.

ASSEMBLY PRODUCTS is making all-transistor dollar-bill changing machines under license from Model Vending Controls. Initial order is for $340,000.

AUTONETICS has a $10.8-million contract for another 191 R-14 radars for Republic's F-105 fighter bombers.

ABOUT 4,700 more mobile transceivers will be built by Budd Electronics under a $2.6-million Army award.

GOODYEAR AIRCRAFT will build a $2.6-million, 50-target simulator for training operators of Navy's W2F-1 early warning planes.

EITEL-MCCULLOUGH will supply and service tubes for Defense Supply Agency under contracts totaling over $1 million.

ELECTRADA reports that last month it sold over $700,000 of its Datacom systems for use in Air Force control and intelligence data-handling systems.

POTTER INSTRUMENT is supplying printers for Pershing and Skybolt ground checkout, and tape transport for Saturn's pcm telemetry. Bendix's Skybolt system tester will also use Epsco digital conversion and signal handling equipment.

ROHR CORP. has a $3-million order from Western Electric for broadband microwave relay antennas to be used in the Bell System.

New from Sprague!

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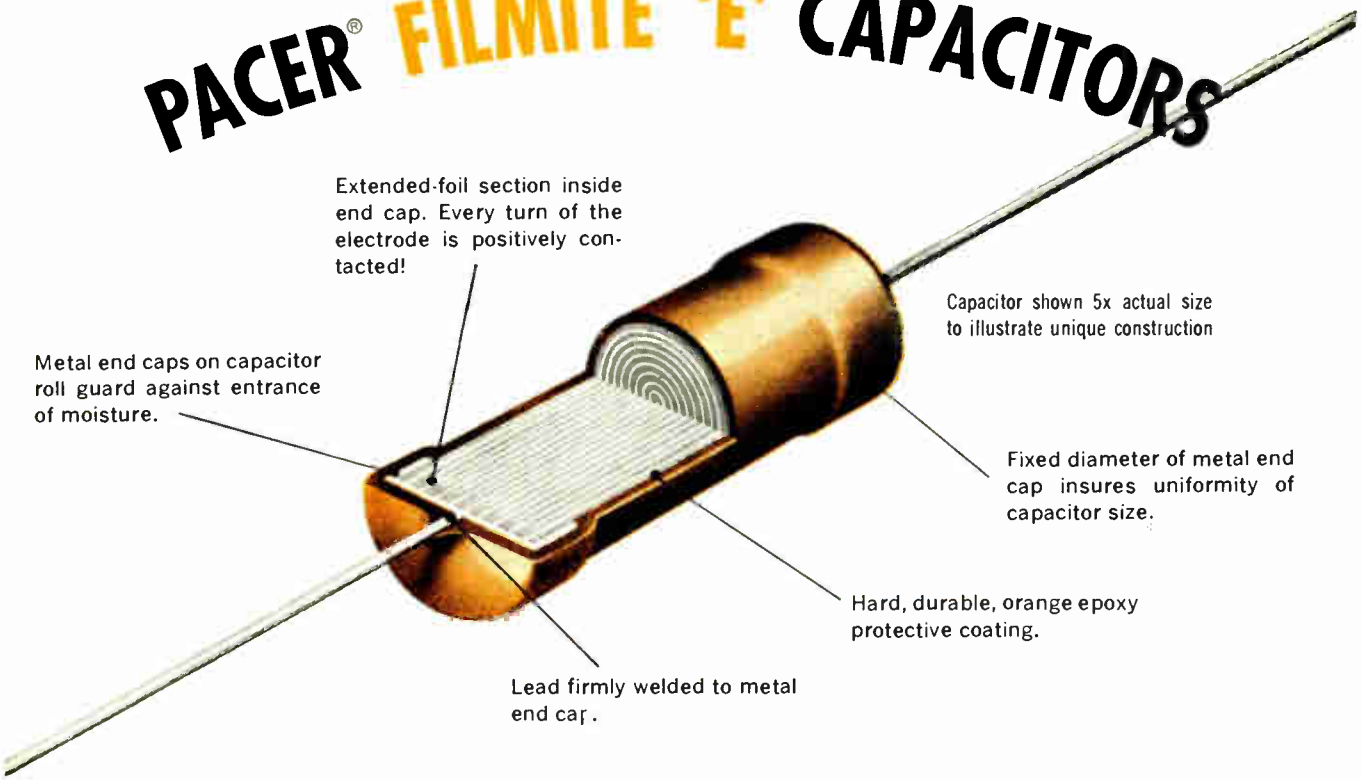

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For complete technical data on Pacer Capacitors, write for Engineering Bulletins 2066 and 2067 to Technical Literature Service, Sprague Electric Co., 35 Marshall Street, North Adams, Massachusetts.

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Vol. I, No. 4

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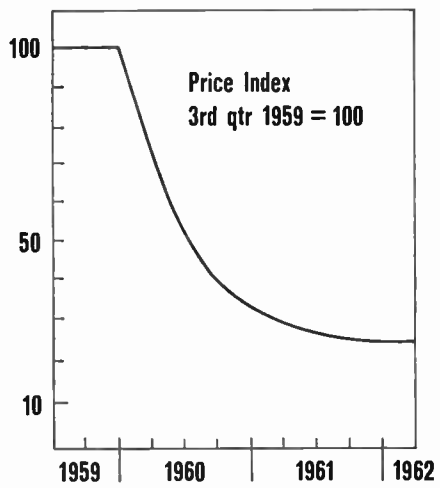

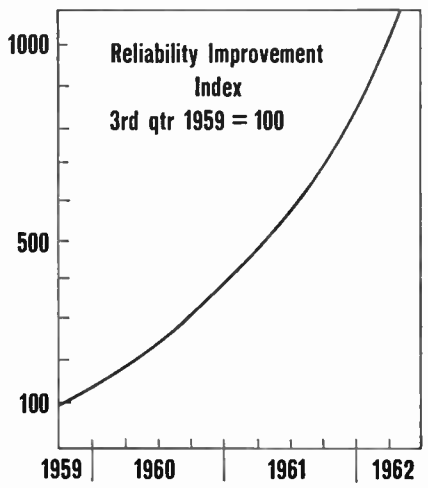

These curves show how Texas Instruments high-volume production capabilities benefit users of alloy transistors.

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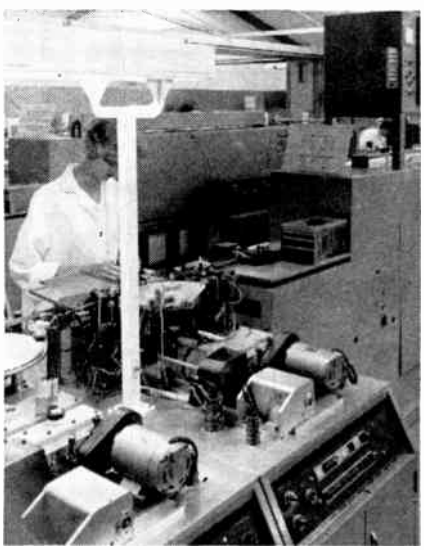

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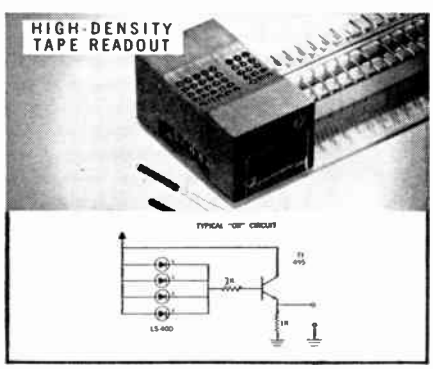
"ten times more sensitive" TI LS-400 planar light sensors provide greater economy

With these new LS-400 light sensors you get extreme sensitivity, a higher-density package, and use-proved reliability. This means you can design more economical circuits, reduce the number of components, and increase over-all circuit performance.

Texas Instruments LS-400 photoconductive sensors give you cycle capability to 25,000/sec — sensitivity ten times that of other subminiature photovoltaic or photoconductive sensors, (typical output 9 ma @ 1000 ft-c), eliminating the need for extra gain stages — temperature stability to 1%/°C — off-storage-on stability to ± 5%. Its highly reliable, planar, surface-passivated construction gives extremely low leakage — two decades (0.001) lower, typically .01 μa in the dark condition. You can design more compact scan heads because the LS-400 exclusive end-reading design requires less space to accommodate the desired number of sensing units.

Now design in the most advanced micro-miniature light sensor available today for your character recognition; tape, card, or microfilm scanning; cataloging; storing or information-retrieval equipment.

For more information write for Bulletin 512-2.



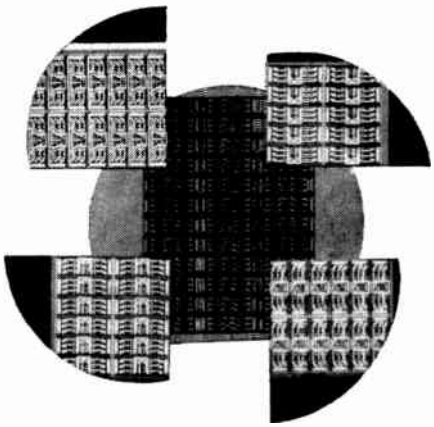
"Master Slice" design...the first economical answer to custom circuits

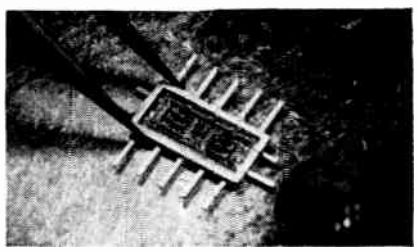
Texas Instruments now offers you hundreds of variations in SOLID CIRCUIT* semiconductor networks. Today you can get the exceptional reliability and miniaturization benefits of SOLID CIRCUIT semiconductor networks in many customized designs — at only slightly more cost than standard, catalog circuits. The flexible "master slice" design concept developed by Texas Instruments makes this achievement possible.

Here's how: First, standard "master slice" integrated circuit bars — complete except for interconnections — are taken from established, high-volume production lines. Second, a special interconnection pattern mask for your circuit is prepared. Third, your special interconnection pattern is photo-etched in aluminum on the "master slice" circuit bar.

Your benefits: You get a complete semiconductor network, integrating resistors, capacitors, diodes and transistors into a single, high-purity silicon wafer — to your specifications. Evaluation samples can be available within several weeks from final design approval. Because preparation of the special interconnection pattern is the only custom step in the manufacturing process, you get most of the economy and delivery benefits of using standard TI production units.

For more information on how "master slice" design offers you the first economical answer to custom circuits, write for Bulletin 512-3.





This is the final stage in assembling your customized Solid Circuit semiconductor networks. Gold wires are ball-bonded between the aluminum lead pattern on the bar and the external leads. The package is then hermetically sealed and your customized semiconductor network is complete.

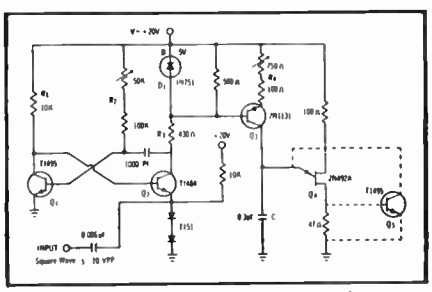
One TI Unijunction transistor does job of several circuit components

Now you can get extra circuit economy with Texas Instruments new unijunction transistor series. These new devices not only replace several ordinary transistors but also eliminate many resistors — thereby giving you greater circuit economy plus over-all improved reliability.

These three-terminal devices exhibit a stable negative incremental resistance region under certain conditions. This negative resistance makes possible the design of unique switching circuits comprising fewer components than conventional transistor circuits. Input impedance in the OFF state is high — about 5 megohms. This feature makes the unijunction suitable for high-input-impedance, voltage-sensing circuits. Circuit simplicity is a major advantage. In many applications of TI unijunctions, such as the staircase wave-form generator and counter circuit below, the number of circuit components can be substantially reduced as compared with conventional transistors. Lower cost, greater reliability, and ease of design are direct unijunction benefits to you.

A full line of 22 unijunction transistors is now available from Texas Instruments.

For more information, ask for Bulletin 512-4 containing a number of useful circuit applications for unijunctions.



New staircase wave-form generator and counter circuit utilizes TI unijunction transistors.

If you would like to have more detailed specifications and application information on the products featured in this advertisement, call your local TI sales engineer or write to Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Texas.

For more information on:

Economical alloy transistors, Bulletin 512-1

TI LS-400 light sensors, Bulletin 512-2

Semiconductor networks, Bulletin 512-3

Unijunction Transistors, Bulletin 512-4

*trademark of Texas Instruments Incorporated

"TI cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement."

SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
13500 N. CENTRAL EXPRESSWAY
P. O. BOX 5012 • DALLAS 22, TEXAS

19550

WASHINGTON OUTLOOK

TFX FIGHTER SUBCONTRACTS ARE STILL UP FOR GRABS

AIR FORCE and General Dynamics officials say there are no firm contracts yet for the new TFX fighter plane's electronic subsystems. GD is still negotiating its prime contract with the Air Force.

Grumman, as associate contractor, and subcontractors are expected to get about 60 percent of the money. GD sources say Litton Industries and GE are major electronic subcontracting possibilities. Still undecided is whether Air Force will contract directly with major components suppliers (as it already has with Hughes Aircraft for the TFX's naval missile system) or whether GD will be, in effect, a weapons system manager with substantial subcontracting authority.

The first development contract will call for 22 prototypes expected to cost about $750 million. Follow-on production contracts for 800 to 1,500 aircraft will bring total costs close to $5 billion.

Air Force version of the TFX will be "optimized" for air-to-ground operation while the smaller and lighter Navy version will be primarily for air superiority or interceptor missions. Each version will have separate radar and fire control systems.

NEW MONEY DOESN'T INSURE RS-70

THE $50 MILLION that Defense Secretary McNamara added to the Air Force's RS-70 program will go for additional research on electronic systems. But McNamara is still opposed to doubling development efforts and beginning full-scale production. Major electronic contractors on the RS-70 are IBM (bomb-navigation system integration), and GE, General Precision Laboratories, NAA Autonetics and Goodyear Aircraft. The Air Force says it is "not known to what extent these companies or others might benefit from the latest $50-million add-on."

COMPETITIVE COST DATA A CLOSED BOOK

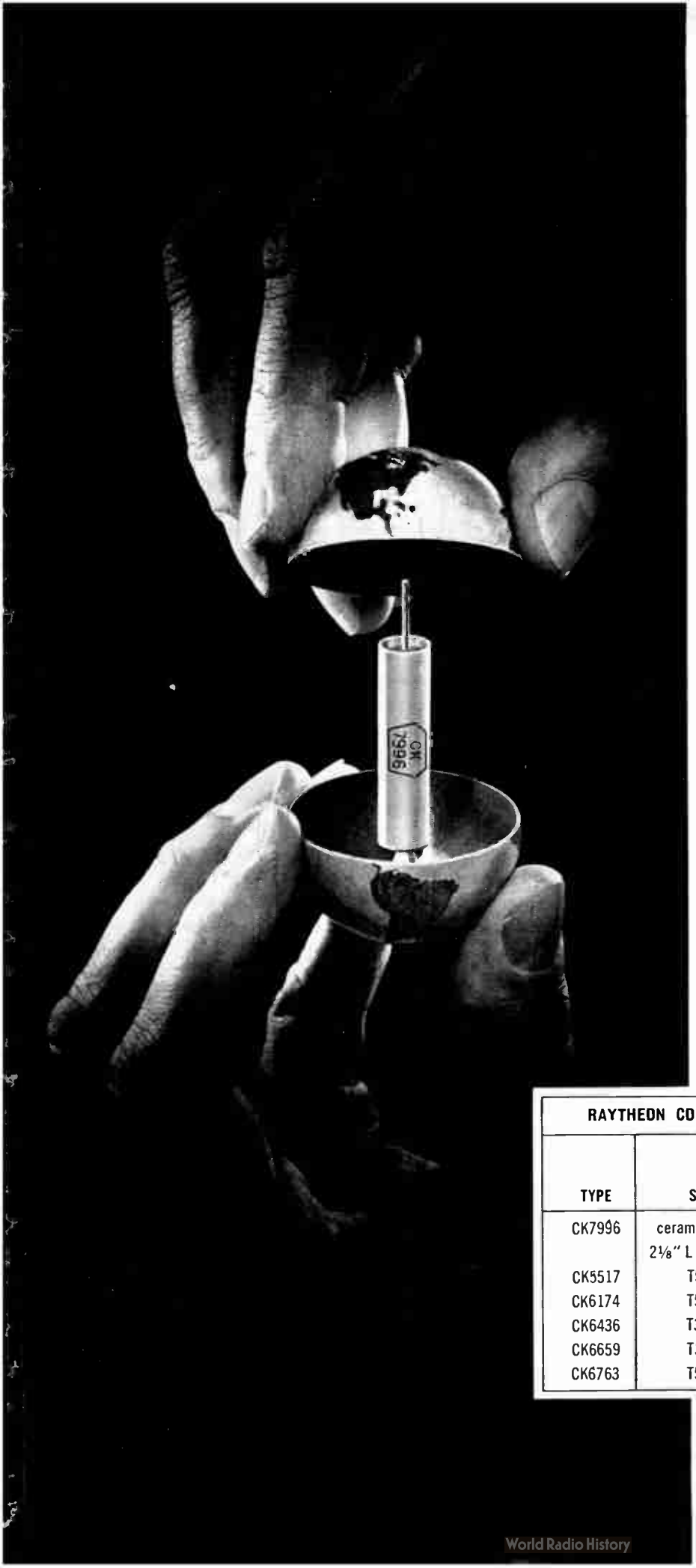
ARMED SERVICES Procurement Regulations have been amended to limit cost analyses by contracting officers only to contracts awarded without adequate price competition. In other words, if contracts are awarded competitively, procurement agencies are not authorized to seek cost data from contractors. Contracting officers also get "full and free access" to books and records used by the contractor to prepare cost data for noncompetitive contracts of at least $100,000. They will not, however, have access to data on costs "incurred in the performance" of contracts.

BIGGEST FIRMS GOT A BIT LESS WORK IN 1962

LATEST LISTING of top defense contractors shows a reversal in the trend toward greater concentration of defense business among fewer companies. In the fiscal year ending June 30, the 25 leading firms held 50.8 percent of contracts, 4 percent below fiscal 1961. The top 100 companies got 72.3 percent, 1.9 percent lower.

Small business' share of prime military contracts increased from 15.9 percent to 17.7. About half the $25.6 billion worth of prime contracts (of $10,000 or more) was subcontracted, one-third going to small companies.

More than half the top 100 companies are in missile, space, aircraft, and electronics work. Lockheed Aircraft, with $1.4 billion in contracts, nosed out General Dynamics as the leading contractor.



Open a world of new applications with CK7996 ceramic-metal high-voltage rectifier

New applications ranging from compact airborne pulse modulator power supplies to ignition systems for gas turbine and jet engines are now open to you with the CK7996.

Subminiature size and exceptional ruggedness are combined in this new ceramic-metal gas-filled half-wave rectifier. The cold cathode CK7996 is designed for high voltage, low current applications. At PIV of 2800 volts, maximum peak current is 100 ma. Tubes can be operated in cascade to produce very high voltages.

For more information on the CK7996 and Raytheon's full line of gas-filled rectifier tubes, please write to: Industrial Components Division, Raytheon Company, 55 Chapel Street, Newton 58, Massachusetts.

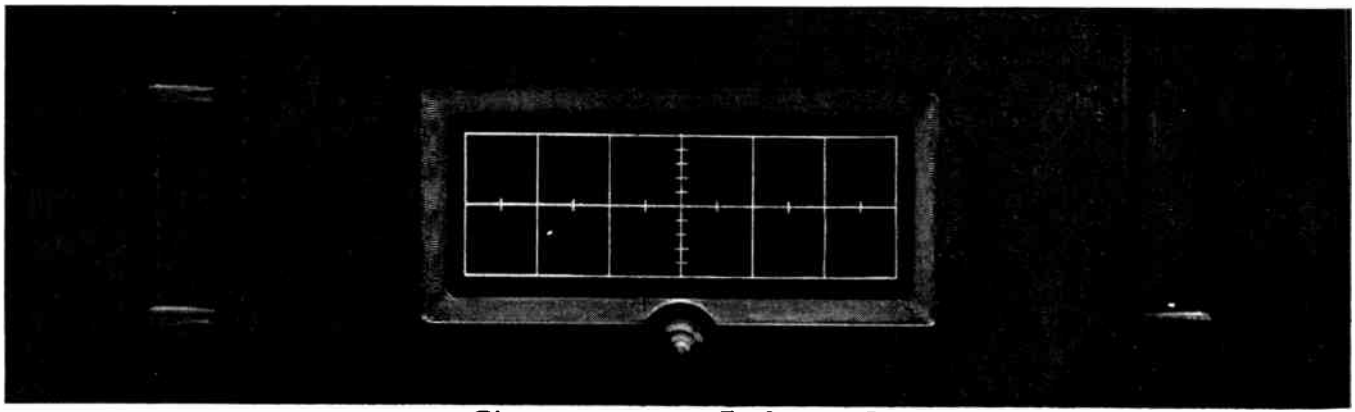
For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor.

RAYTHEON COLD CATHODE GAS-FILLED RECTIFIER TUBES

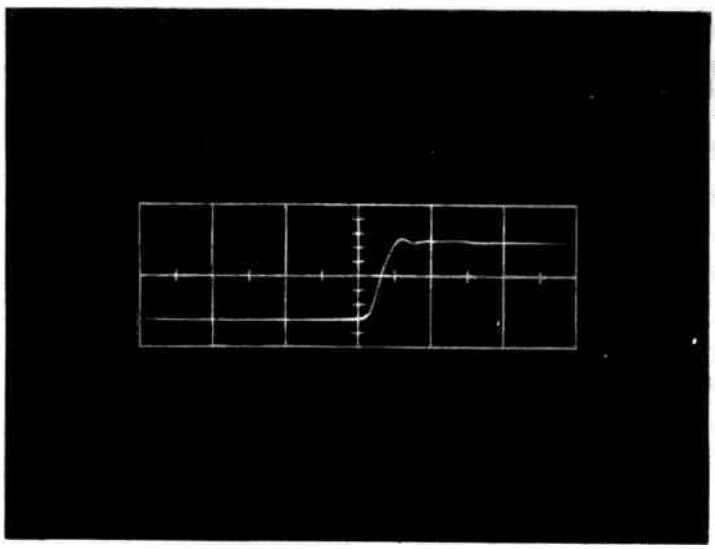
TYPE	SIZE	MAX PIV VOLTS	MAX PEAK CURRENT STEADY STATE ma	MAX AVERAGE CURRENT mAdc
CK7996	ceramic-metal 2⅛" L x 0.4" OD	2800	100	12
CK5517	T5½	2800	100	12
CK6174	T5½	2800	30	3
CK6436	T3	2000	5	0.3
CK6659	T3	2800	40	8
CK6763	T5½	2800	100	12

RAYTHEON

CIRCLE 13 ON READER SERVICE CARD



See anything?



This new film did.

This new film saw something the eye couldn't: the rise time of a single pulse on a Textronix 519 scope at a sweep rate of 2 nanoseconds/cm. The new film, Polaroid PolaScope Land Film, actually extends the usefulness of existing oscilloscopes by supplying "brightness" that the scope hasn't got!

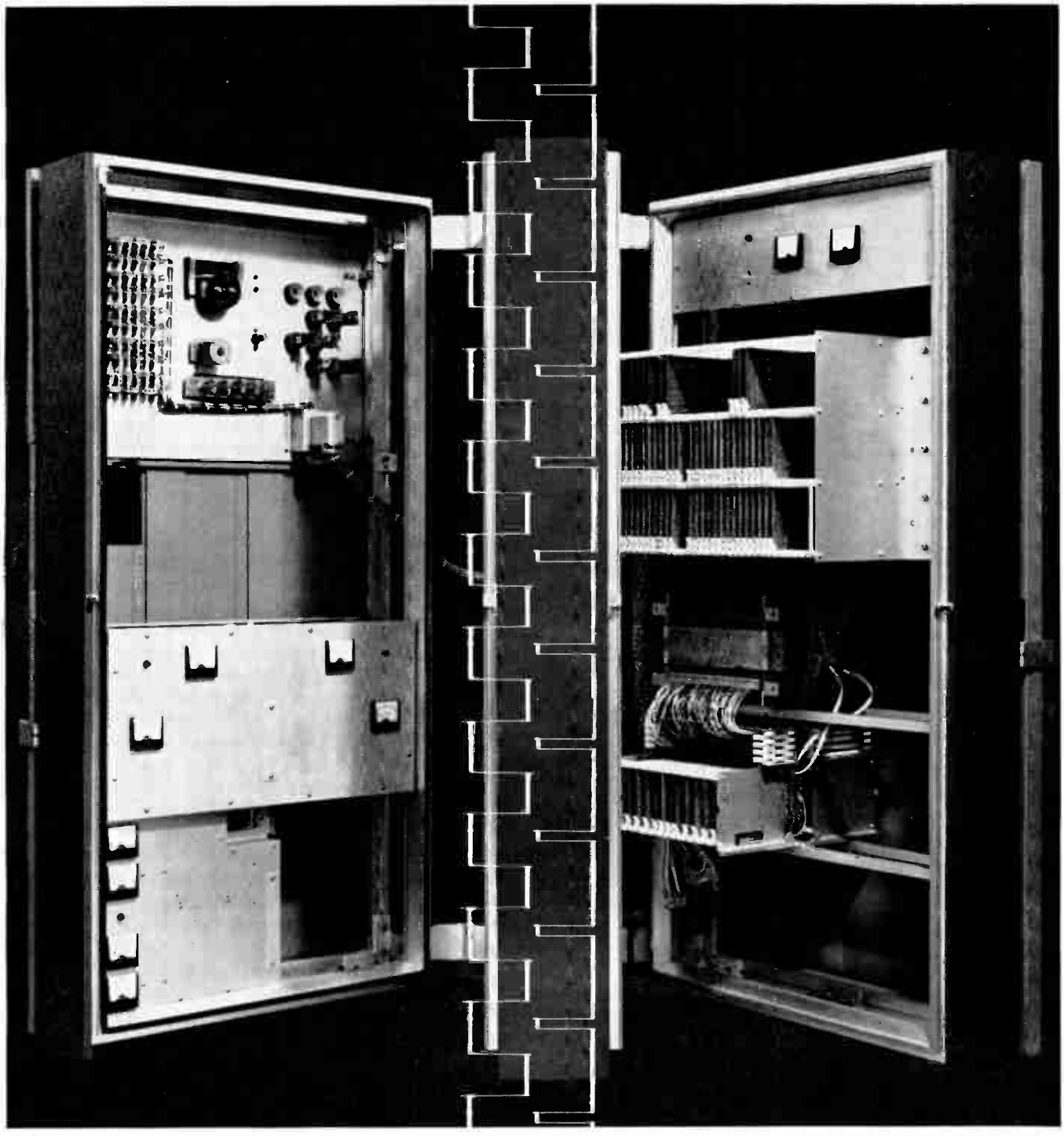
The reason is that this PolaScope film has an ASA equivalent rating of 10,000, which means it can see things your eye cannot. It has about twice the writing rate of the Polaroid 3000-speed film, currently the standard for high speed oscilloscope photography. (No other commercially available films come anywhere near the speed of PolaScope film.) And because it's made by Polaroid you get a finished usable print—see above—ten seconds after exposure.

PolaScope film will also give you better shots of slower pulses and stationary waveforms. So little light is required, camera aperture and scope intensity can be reduced considerably, and that's how to get really sharp oscilloscope pictures.

And wherever else light is at a premium—such as photomicrography and Kerr Cell photography—PolaScope film will make new applications possible, old applications more useful.

PolaScope Type 410 Film is packed 12 rolls to the carton. The price is about the same as the Polaroid 3000-speed film. For the name of the industrial photographic dealer nearest you, write to Technical Sales Department, Polaroid Corporation, Cambridge 39, Massachusetts. POLAROID®

New Polaroid Land 10,000-speed film for oscillography



What 16,384-word core memory has a complete cycle time of 1 microsecond? **AMPEX LZ**

There you have it: the fastest large core memory today. The Ampex LZ. Its cycle time: 1 microsecond. Its capacity: 4096 to 16,384 words. It can handle word lengths of 18 to 72 bits, in 2-bit increments. It can read-restore and clear-write. And it offers twice the capability of the largest memory previously available. Yet occupies approximately half the space. Power requirements are also reduced—by 50%. Second in a series of high-

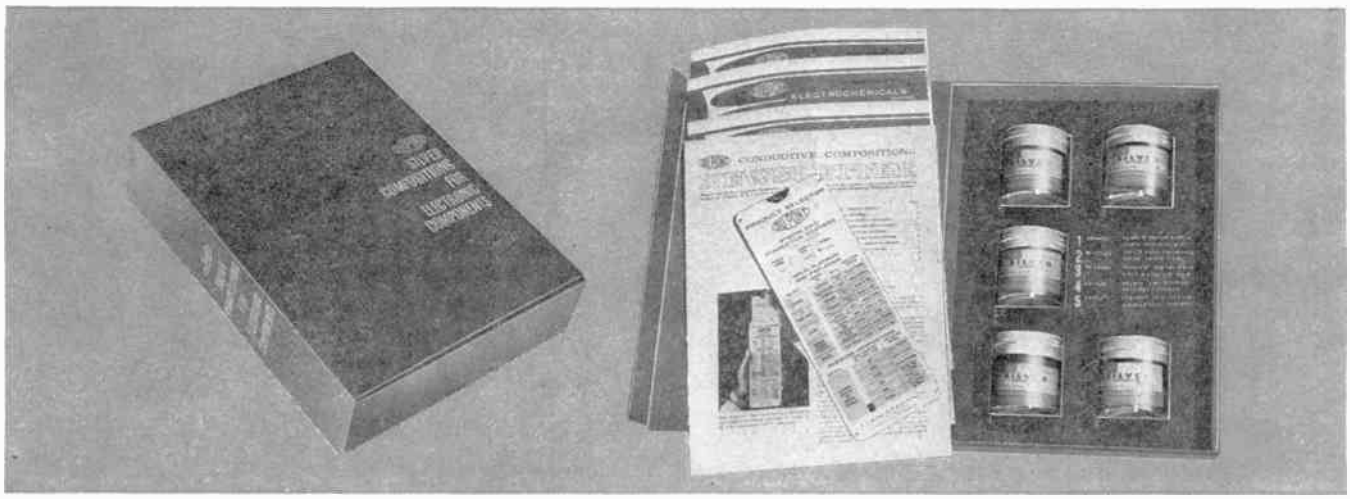
speed Ampex memories, the LZ is packaged in a new tri-sectional cabinet for easier accessibility. It's made by Ampex Computer Products Company, Culver City, California. A division of the only company providing recorders, tape and core memory devices for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Sales and service engineers throughout the world.

0/1 AMPEX

DUPONT **Ideas and uses for Du Pont**

Conductive Compositions

■ Conductive silver, gold, palladium and platinum compositions
■ Resistor compositions ■ Gold and silver cement compositions



New Kit acquaints you with Du Pont Conductive Silver Compositions...helps you to produce better electronic components

Our new Conductive Silver Coating Kit has been developed to give you a choice of Du Pont Silver Compositions with which to experiment.

The kit contains 5 different silver compositions (5 oz. each) ranging from an air-dry silver to a solderable, high-firing temperature silver. The silvers can be used on all substrates from ceramic to paper. Literature detailing the application procedure for each silver Composition is also included in the kit.

We feel that this kit will help you better understand the range of conductive compositions available to you from Du Pont and help you select the right composition for the right job.

The cost of each kit is $50 (postpaid).

Please check #1 and send purchase order with coupon below to receive your kit—allow a month for delivery.

New Resistor Compositions allow you to control noise, temperature coefficient and resistance values

The new compositions are #8020 (1 ohm/square) and #8025 (20K ohm/square). Intermediate resistance values may be obtained by blending the compositions. The resistor surface is very smooth, facilitating adjustment by electric arcing.

The table shows how noise, temperature coefficient, and resistance value can be controlled, making it possible to choose a blend which will satisfy your specific circuit needs.

Weight Per Cent #8020/ #8025	Approximate Resistance Value, ohms/ square/mil	Temperature Coefficient of Resistance ppm/°C	Noise, db/decade
100/0	1	±300	−35
20/80	500	±200	− 5
10/90	1000	±175	0
5/95	5000	±150	+10
0/100	20000	±300	+15

Resistors made from Du Pont's 8000 series and the earlier 7800 and 7900 series have high-power dissipation, stability at high temperature and are relatively insensitive to moisture and abrasion. Du Pont Resistor Compositions are easy to apply by brush or stencil screen and can be fired simultaneously with the conductor. For details, check #2 on coupon.

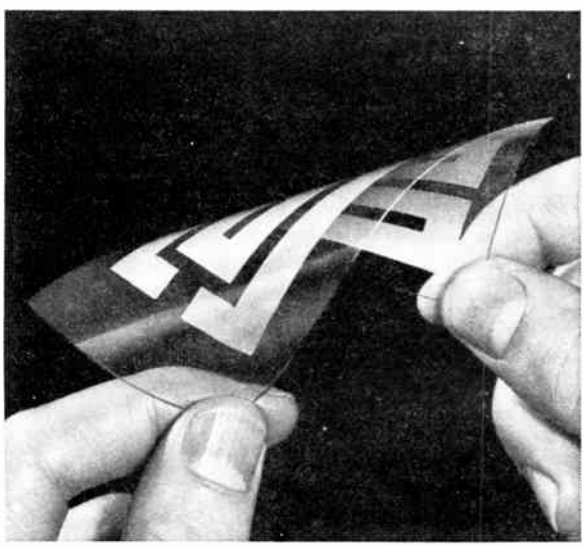
Du Pont Silver Coatings make effective, economical static shields

Anyone now using aluminum foil for "rf" shielding will be interested to know that Du Pont's Conductive Silvers perform this function with notable ease of application and economy. They are easy to apply and avoid material waste. They also have unusual permanence.

Size of the part of assembly makes little difference. Some firms use silver coatings to shield single parts as well as components. Others have used these coatings to shield walls, ceilings and floors of entire rooms—giving a static shield that is readily covered with a decorative finish, if desired.

Du Pont Silver #4817 is applied by spray or brush and air-dried. Silver #5815 is applied the same way and will thermoset at temperatures above 320°F.

Check #3 on the coupon for further information.



How to apply permanent conductive coatings on flexible surfaces

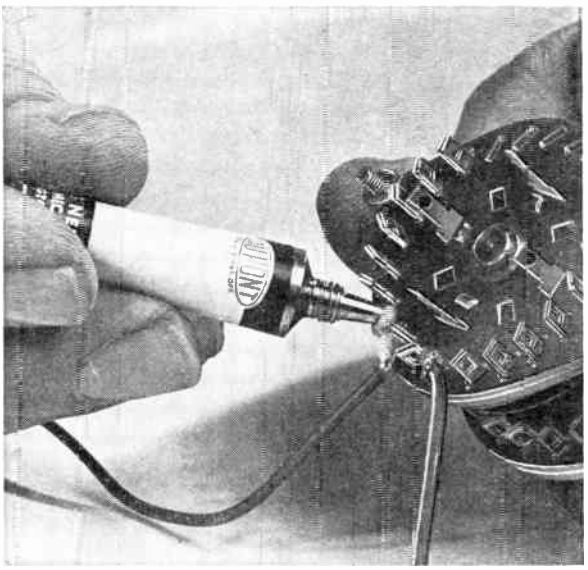
When surfaces are so pliable that ordinary air-dry conductive coatings flake off when flexed, use Du Pont Air-Dry Silver #7941.

This is the conductive coating especially created for pliable substrates. It flexes with paper, plastics, and other nonrigid materials.

You can use it to print conductive patterns, circuits, and static shields. After drying, it has good thermal and electrical conductivity —in addition to its unique flexibility.

For details, check #4 on the coupon.

Now...a one-package conductive adhesive that eliminates soldering



For fast, strong conductive bonds without soldering or heating use Du Pont Air-Dry Silver #8030. It gives you a strong bond and, since no heat is required, sensitive electronic components are not harmed.

This air-dry adhesive is easy to handle and apply.

It finds use wherever conventional solder is now used: for termination and attachment of components to circuitry.

For details on this experimental air-dry adhesive, simply check #5 on the coupon.

DU PONT
REG U.S. PAT OFF

Better Things for Better Living... *through Chemistry*

Ceramic Products
Electrochemicals Department – Room D-2058B
E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Del.

Please send me further information on the Du Pont conductive compositions which I have checked below.

- #1 ☐ Conductive Coatings Kit—$50. postpaid—please include purchase order
- #2 ☐ Resistor Compositions
- #3 ☐ Silver #4817 and #5815
- #4 ☐ Air-Dry Silver #7941
- #5 ☐ Air-Dry Silver #8030 (adhesive)

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Navy Sets New Standards for Airborne Equipment

Microelectronics and new reliability specs now being issued

By MICHAEL F. WOLFF
Senior Associate Editor

WASHINGTON — New specifications for microelectronic assemblies and for reliability now face naval avionics equipment contractors. The reliability specs will apply to all new naval avionics gear, conventional as well as microelectronic.

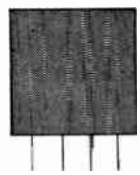
Navy defines avionics as airborne electronics, including flight instruments and accessories, but not fire-control radar.

Portable Dish for Relay

STEERABLE *30-foot antenna developed by Antenna Systems, Inc., for ITT Federal Labs can be transported on two trailers or by air carriers. ITT will use the first one for the Project Relay satellite program*

MICROELECTRONIC MODULAR ASSEMBLY

TO-5 CAN



THIN FILM MODULE IF NEEDED

(A)

NAVY'S INITIAL CONCEPT *of (B) for use in plug-in mainte-*

THE WORD GOES OUT THIS WEEK

Col. A. C. Lowell, director of avionics, Bureau of Naval Weapons, was scheduled to present this week the BuWeps proposal for functional microcircuits.

The meeting, in Philadelphia, of the EIA Advisory Committee on Microminiaturization, is also expected to hear a discussion of the final version of microelectronics nomenclature and definitions. EIA will then issue these to the industry, if they are approved

Both sets of specifications are part of the Navy's program to improve such systems by introducing quantitative reliability and maintenance procedures and by gradually introducing basic functional microelectronic circuits. Aircraft equipment will become increasingly more microelectronic assemblies (ELECTRONICS, p 24, Oct. 12).

MICROELECTRONICS—Navy is planning to detail some 200 functional microelectronic circuits — more than half the circuits to be used in future airborne systems. Bureau of Weapons officials told ELECTRONICS use of the circuits will be enforced as they are detailed.

Plan is to have performance specs much like MIL-E-I for electron tubes and MIL-S-19500 B for transistors. The basic microelectronic document is now Naval Air Development Center Spec E15-13A. It will be changed to a MIL spec in about a year.

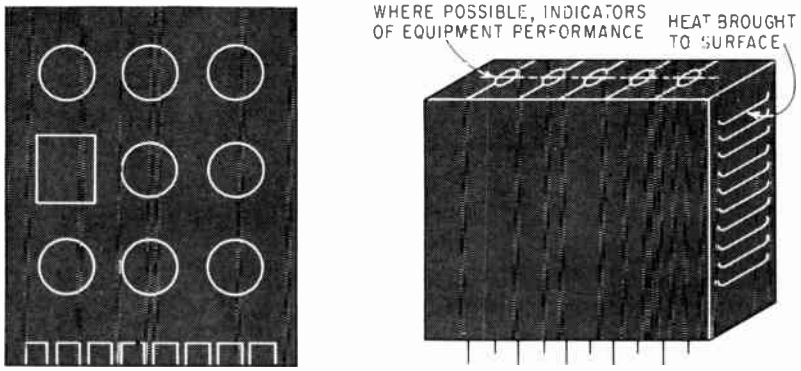
EL5-13A is an overall spec for microelectronic modular assemblies. When completed, it will call for a maintenance module like the one illustrated. The module will be a basic circuit such as a logic gate or pulse generator.

The spec will show the actual circuit and such details as waveshapes, temperature characteristics and speed. While it will not specify fabrication procedures, EL5-13A prefers that modular assemblies be constructed by one or a combination of the following:

- All active and passive devices formed by diffusion, deposition or other suitable techniques in or on a semiconductor substrate
- All active and passive devices deposited as thin films on suitable substrates.

Some detailed circuits may be available in a year. Meanwhile, Navy will issue 80 preliminary circuits in a "Manual of Proposed Electrical Characteristics for Microelectronic Functional Modules." These will be available in limited quantities from the Bureau of Weapons in about six weeks. Circuits will be mostly digital; only a physical outline, input and output voltages and frequencies, impedances, and approximate input and output waveforms will be given.

RELIABILITY—Five or six docu-



how to assemble microelectronic functional modules (A) to mother boards nance modules (C) containing several mother boards

ments will be used in a three-step reliability program.

First step is that the Navy will establish a mean-time-between-failure goal in the R & D contract. Before beginning design, the contractor will be required by an updated version of MIL-R-22256 (AER) to make an analysis and prediction of whether the goal can be met by his design.

Contractors will be required to use a new document, MIL-HDBK-217. It will be on sale by the Superintendent of Documents in approximately 10 weeks under the title "Reliability Stress and Failure Rate Data for Electronic Equipment."

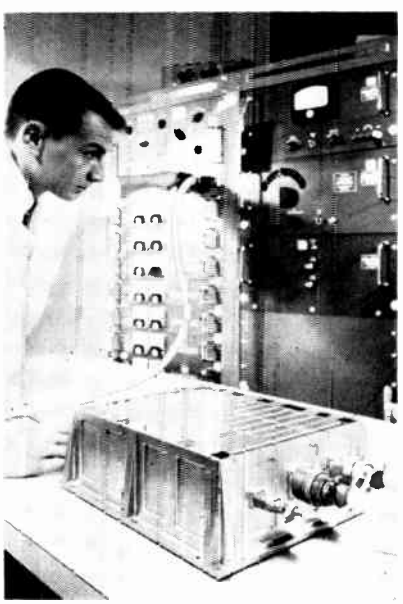
Second step will be a test demonstration on several equipment models to prove the design goal has been met. If the test fails, the equipment may be redesigned or the goal revised. The spec will be MIL-R-22973 (WEP).

Final step will be to prove that what has been established at the R & D stage can be maintained in production. According to BuWeps, this will involve more scientific testing and sampling to be performed under MIL-R-23094 (WEP) and a proposed spec titled "Test Levels and Accept/Reject Criteria for Reliability of Non-Expendable Electronic Equipment".

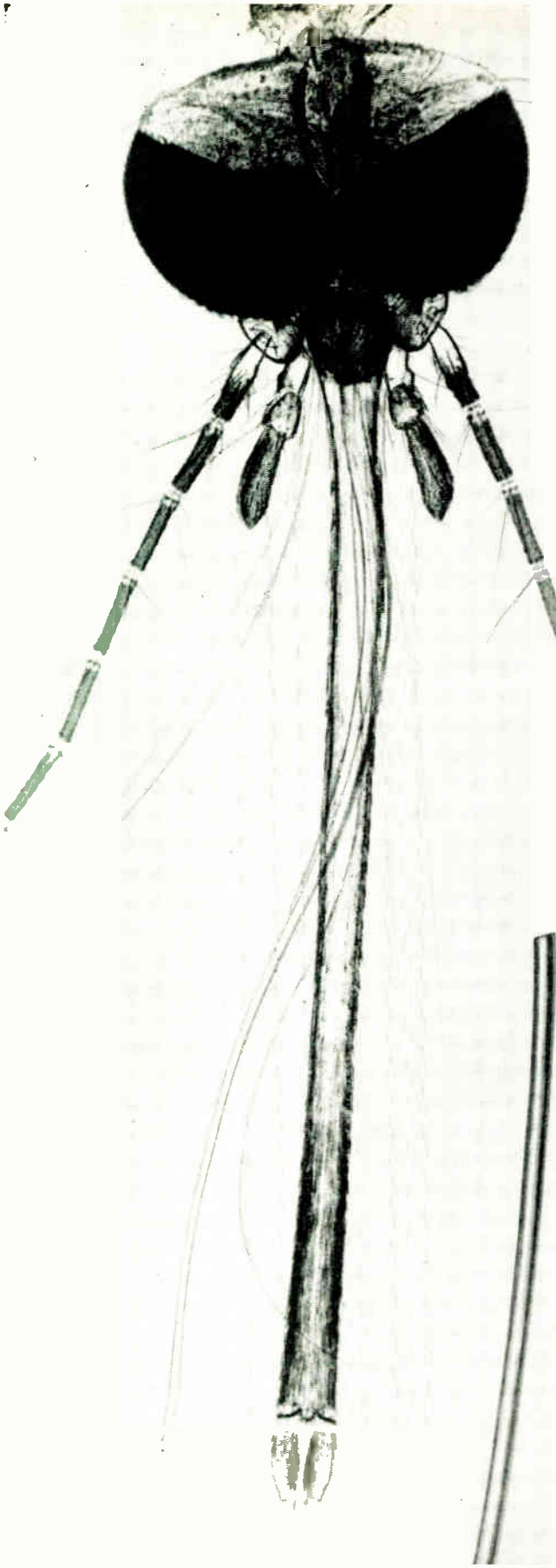
The latter standard is intended to provide uniformity in reliability testing. It will outline a series of test levels for demonstration tests, longevity tests, and the reliability qualification and sampling phases of production acceptance. These levels include conditions of temperature and temperature cycling, on-off cycling, input voltage cycling and mild vibration.

Several test plans for production acceptance are also given. They specify the quantity of equipments required in terms of time and failures. Presently they call for testing the first 22 equipments produced, but this may be lowered.

Delay-Line Computer



GLASS *delay lines (see p 60, Nov. 9) handle input-output chores, contain arithmetic and control registers and act as temporary memory in new high-speed miniature computer developed by Librascope for aerospace applications. Circuits are mounted on removable, heat-conducting walls of package. Modular design permits expansion. Computer also has permanent memory of 8,192 28-bit words*



Nature has given the mosquito a proboscis that measures 0.0031 of an inch at its widest point. Nickel makes it possible to produce tubing that's much finer.

How fine? The tubing pictured here—drawn by the Superior Tube Co.—has an outside diameter of 0.0019 of an inch, a wall thickness of 0.00065 of an inch and an inside diameter of 0.0004 of an inch!

But the smallest tube ever made is still much finer. The fact is, that nickel tubing has been drawn down to 0.00061 outside diameter and 0.000036 inside diameter. *That's* really fine!

SMALL WONDER

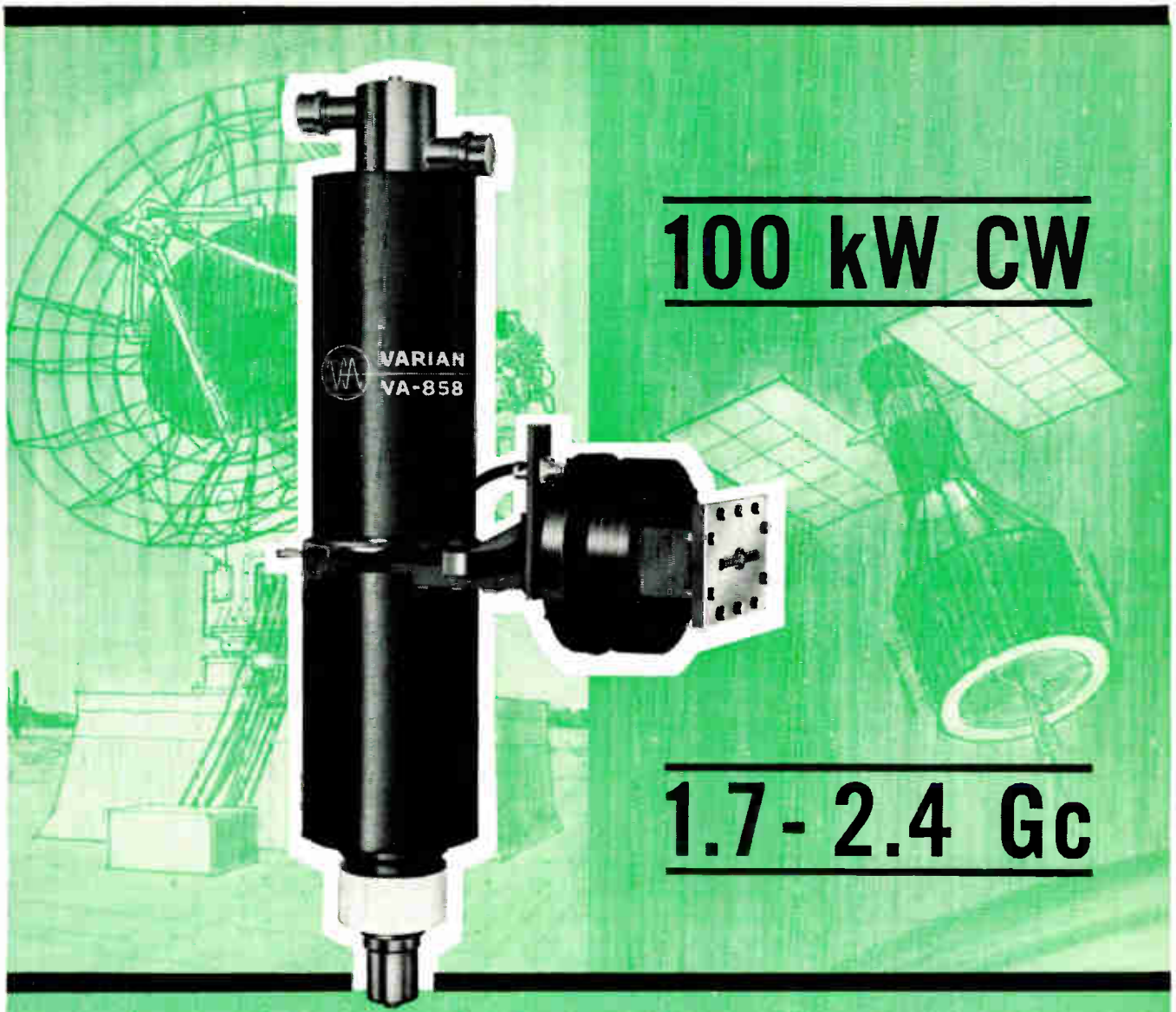
...that tubing finer than a mosquito's stinger calls for a Huntington Alloy!

Tiny tubing like this is just one example of how you can get Huntington Alloys in any form or size you may want, right down to the fine sizes produced by specialists in strip wire and tubing. In commercial production, Huntington high-nickel alloys are made in tube forms from 0.010 inch outside diameter to the giant welded cylinders used in paper-making machinery. They're also available in wire and strip forms. And in all the other various shapes and sizes needed for electronic applications.

Perhaps a Huntington high-nickel alloy can help you solve one of your electronic problems? Write for the informative booklet, "Huntington Alloys for Electronic Uses." It will give you a convenient reference on the properties, available forms and typical applications of these alloys.

HUNTINGTON ALLOYS INCO TRADE MARK

HUNTINGTON ALLOY PRODUCTS DIVISION
THE INTERNATIONAL NICKEL COMPANY, INC.
HUNTINGTON 17 • WEST VIRGINIA



100 kW CW

1.7 - 2.4 Gc

FOR DEEP SPACE COMMUNICATIONS

Varian Associates' new VA-858 CW amplifier klystron offers the highest known power in S-band for deep-space communications. Developed by the same team of engineers who brought the industry the highest power in X-band, the VA-858 is conservatively rated at 100 kW, and in actual continued operation has delivered in excess of 175 kW. The VA-858 is available in four models. Tubes can be tuned for high gain, high efficiency, or wide bandwidth. With suitable stagger tuning, a 3 db bandwidth of 20 Mc can be achieved, with a power gain of 50 db. Tuning range of each tube is 150 Mc below 2 Gc, and 200 Mc above 2 Gc. Small size of the tube is ideal for antenna mounting.

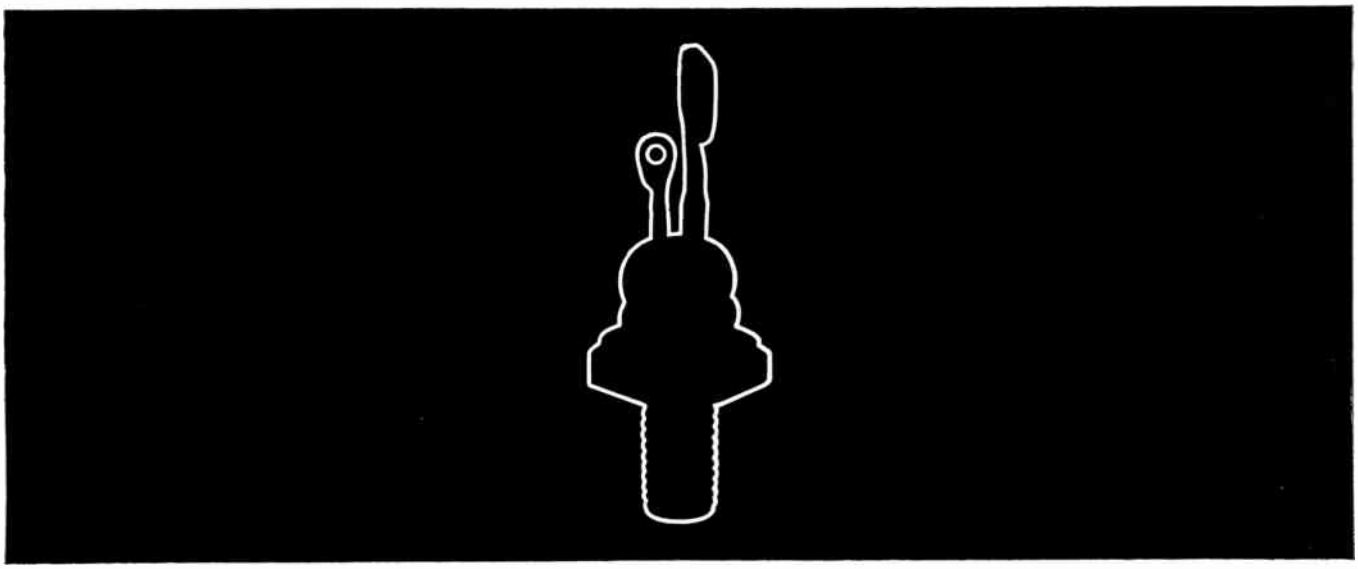
If your deep-space or satellite project requires such exemplary tubes, Varian has (or can design) the tube for you. Write Tube Division.

CHARACTERISTICS:	SYNCH TUNED	HIGH EFF. TUNED	BROAD-BAND TUNED
Power Output (kW)	103	122	122
Drive Power (mW)	35	350	1000
Gain (db)	65	55	51
Efficiency (%)	35	41	41
Bandwidth, 3 db (Mc)	8.5	15	21
Beam Voltage (kVdc)	35	35	35
Beam Current (Adc)	8.5	8.5	8.5

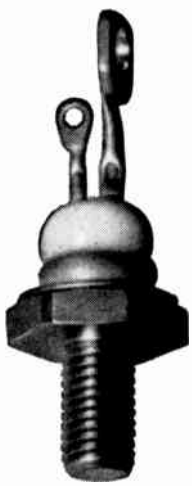
VARIAN associates

TUBE DIVISION • Palo Alto 1, Calif.

MICROWAVE TUBE GROUP | PALO ALTO TUBE DIVISION • BOMAC DIVISION • S-F-D LABORATORIES, INC. • SEMICON ASSOCIATES, INC. • VARIAN ASSOCIATES OF CANADA, LTD. • SEMICON OF CALIFORNIA, INC.



Why you couldn't buy a Fansteel controlled rectifier until now



You may be one of the frustrated silicon controlled rectifier purchasers who approached us several months ago . . . prior to our entry into the SCR field. We were asked to design and produce a unit that would:

1. Resist severe thermal fatigue.
2. Be of uniform structural quality and characteristics.

We have good news for you.

Fansteel development engineers have overcome problem No. 1 with a special hard-solder construction that can take repeated thermal shocks.

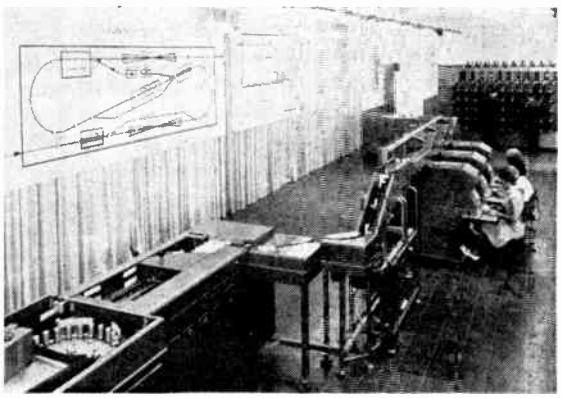
Problem No. 2 was met and solved by adoption of all-diffused construction. Fansteel engineers found this method vastly superior to the conventional combination of alloying and diffusion.

Thus, Fansteel can now announce the availability of a silicon controlled rectifier line that can handle power, switch it fast, and not come apart in the process.

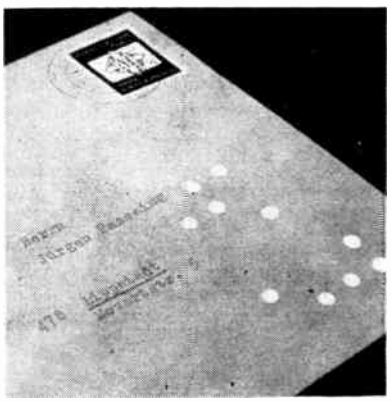
These compact Fansteel SCRs presently range in blocking voltages from 50 to 500 PRV, with RMS output currents at 4.7, 10, 16, and 25 amps. Maximum operating temperatures: −65° C to +150° C (4.7 amps), −40° C to +100° C (10 amps), −65° C to +125° C (16 and 25 amps).

Be our guest and test one of these new Fansteel SCRs. Just write to Glen Iaggi, Rectifier-Capacitor Division, Fansteel Metallurgical Corporation, North Chicago, Illinois.

FANSTEEL RC
METALLURGICAL CORPORATION
RECTIFIER-CAPACITOR DIVISION



GENERAL VIEW *of Telefunken's automated letter handling line*



ULTRAVIOLET *light reveals code on letter*

GIRLS MUST *still code the letters manually. This is Siemens' coder*

West Germany Automates Letter

Postal service installing new systems in 5 cities; 3 firms built prototypes

By RICHARD MIKTON
McGraw-Hill World News

BONN—Five West German post offices will have what is reportedly the most advanced letter handling systems in the world when automated equipment goes into operation late next year.

The systems—to be installed at Bochum, Augsburg, Coblenz, Brunswick and Heidelberg—will automatically cull, cancel, stack, feed, code and sort both ingoing and outgoing letters. They are expected to replace some of the 25,000 workers who now process the 30 million letters which flow through West German post offices daily.

The new systems will employ improved models of units developed by Standard Electric Lorenz (ITT), Siemens and Telefunken. The Postal Ministry has tested these during the past year.

COMPLÆTE SYSTEM — Telefunken, which makes a complete line, says its equipment can sort 20,000 letters an hour for routing in 100 different directions. Telefunken's system will cost about $500,000 for commercial installations.

Features of the system include:

- Fast-moving endless belts. Preset gages reject letters too thick to pass underneath.
- Photocells which identify stamps quickly and accurately. Stamps are treated fluorescently or phosphorescently.
- Magnetic ink and fluorescent coding. One code is used for outgoing mail, the other for incoming.

The present system has one bottleneck: the manual coding operation. It now takes six coders to keep up with one of the sorting lines. It is hoped that automatic readers for typewritten characters will eventually speed up this process. Both Siemens and Telefunken are working on these.

CODING—Coding is dependent upon a numbering system that has been established for West Germany's 24,000 postal zones. The one, two, three or four-digit numbers precede the city or town name and are read by an operator at the coding desk. She manually keys them into a printer which presses a 2-out-of-5 code onto the envelope. The code is later read under ultraviolet light to determine which bin the letter should go into.

When the numbering system was proposed, it was feared the West German public would be reluctant to take to it. But the opposite has been true and the numbers now appear on 75 percent of letters.

OTHER GEAR—Contributions to the new system vary greatly among the three companies involved.

Telefunken, which apparently has buoyant hopes for the future in this area of automation, has been the most active. SEL has concerned itself with only one area—that of the culling and facing equipment. Siemens is building two items, although they are the most complicated in the line: the coding desk and the sorter itself.

Telefunken and Siemens each developed a sorter. In the Telefunken setup, a magnetic-drum memory and magnetic coils will enable untrained people to rapidly change programs. A comparison circuit will match recorded postal code numbers with those in the memory. When two numbers coincide, an electric switch will initiate reading out of the associated bin number. The number will be applied to the input of a continuous switching register in the sorter through a further buffer storage.

The Siemens system also sorts to 100 destinations. Data is recorded in code form on a 10-contact plate mounted above each pocket of the sorter. One hundred guide channels

END OF THE LINE. *Letter bins in the Siemens system*

Handling

arranged in a circle, each with a container attached to its bottom end, rotate below the pockets. As soon as a filled pocket passes the appropriate guide channel, the code plate actuates a set of contacts. The pocket then opens and the letter drops into the channel. Protected gas contacts are used because of the heavy dust from the letters.

Europe's First Electronic Exchange Starts Trials

LONDON—First trials of the British Electronic Telephone Exchange installed in a London exchange are underway. The system, jointly developed by the General Post Office and five manufacturers, employs time division multiplex modulation with a 10-Kc cycling frequency to transmit groups of 100 channels.

Semiconductor - diode gate switches of the 800-line exchange are sequence-controlled, opening for 1-μsec in every 100 μsec. Each incoming subscriber call is allocated a particular 1-μsec time-slot.

Local and main memories work together to allocate vacant time slots, record calls and provide permanent information on subscriber details and routing instructions. Local memories are delay lines and the main memory is a drum.

Less Nuclear Secrecy Sought

Restrictions impede satellite communications program, says forum

WASHINGTON—Relaxation of secrecy restrictions in the development of nuclear power for space applications was urged last week at the Atomic Industrial Forum's annual meeting.

The call for wider dissemination of information was made by Jerome G. Morse, of Martin Marietta, during an opening-day panel. The panel focused on the need for early establishment of technical requirements for the Rover (nuclear rocket) and Snap (electrical power generator) programs.

GENERATORS—Morse presented conclusions of a 15-man AIF committee studying development of Snap devices for communications satellites.

The report found that "many existing restrictions seem to needlessly impede the interchange of information between users and developers, both in industry and government."

It was recommended that maximum information on design, cost and performance characteristics of nuclear power sources and launch vehicles be made available to the civilian communications satellite program.

Morse added that communications satellites through the late 1960's will need 60 to 300 watts of power for transmitters. The satellites will also need lifetimes of 10 years for economical operation. He said that radioisotope generators can fill the needs and that, unlike solar cells, they are not damaged by radiation.

SURVEYOR—Advantages of nuclear power sources over solar cells were also cited by Tom Carvey, of Hughes Aircraft. He discussed the Surveyor spacecraft that will land on the moon in the 1960's.

Though radioisotope generators will weigh 8 pounds more than solar cell equipment in the first Surveyors, he said, they'll be able to work "around the clock"—in darkness as well as light.

One of Surveyor's primary missions will be to drill holes into the moon to sample the moon's composition. This will require about 1 Kw of power, Carvey added.

Computer Controls Going In Another Steel Mill

HOUSTON—A slab and plate mill, controlled almost entirely by automatic electronic devices, is nearing completion at an Armco Steel plant here.

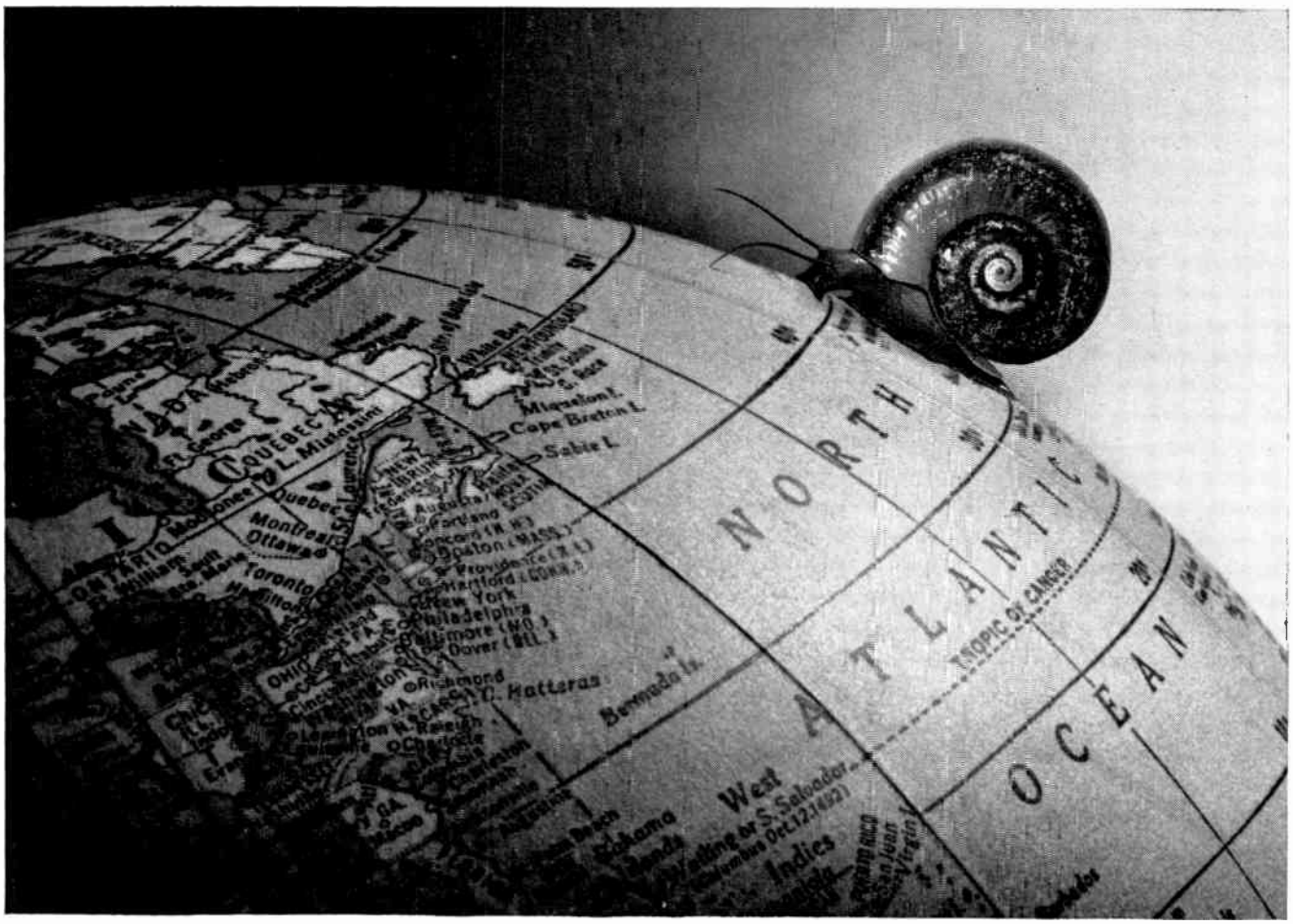
Virtually all production controls will be geared to a Westinghouse Prodac computer system (p 7, June 8) integrating closed circuit television monitors, temperature controls, rolling machinery, and transfer equipment for both slabbing and plate production. The computer systems, X-ray gages, and temperature sensors will maintain quality.

The mill, with an overall length of 1,900 feet, will handle ingots weighing up to 35 tons.

Dry Run to Moon

LANDING *simulator, one of four built by Boeing to study space flights, uses tv to project relief map of moon and an analog computer to simulate spaceship operation*

Q. Who has the facts about controlling speeds as slow as one revolution per day?



A. The Creators of the KOLLMORGEN Model 711 Precision Rate Table

They'll tell you that this instrument for testing rate gyros and inertial guidance systems meets the most exacting requirements. *It's sensitive* to command signals of 0.02 radians per second per volt of reference voltage.

It's accurate within 0.2% of set point. *Its 30,000-to-1 range of table speeds* extends from earth's rate to 2 radians per second.

You'll learn that two direct-drive components* are keys to this rate table's superior performance. A d-c tachometer generator, with low-ripple output of 50 volts per radian per second, is responsive to rates as slow as one revolution per year. A gearless torque motor eliminates back lash and provides torque-to-inertia ratios many times higher than an equivalent gear train servo motor.

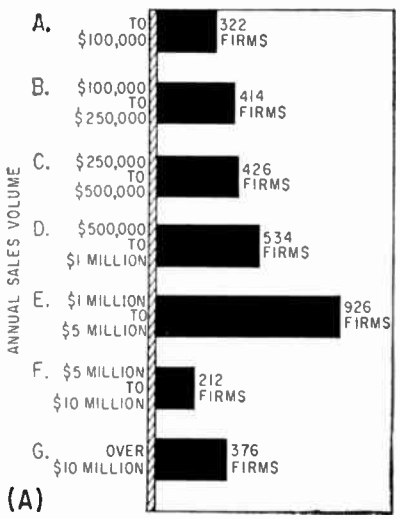
What is your question? If it is in the area of remote viewing, aligning, testing, measuring or controlling, the answer may already be among the growing number of optical/electronic/mechanical components and systems engineered and produced by Kollmorgen and its subsidiaries.

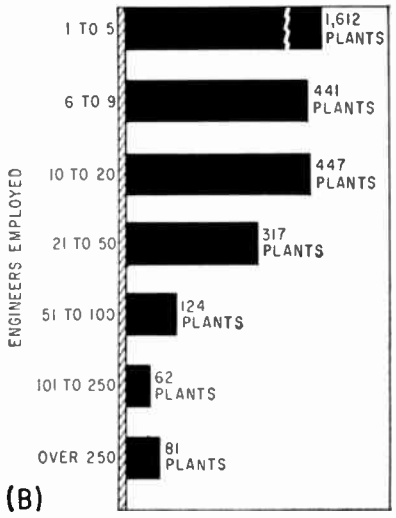
Write for literature describing the combined capabilities and facilities of Kollmorgen, Instrument Development Laboratories and Inland Motor Corporation.

*Products of INLAND MOTOR CORPORATION

KOLLMORGEN may already have the answer to your next question in optics or electromechanics.

KOLLMORGEN CORPORATION • NORTHAMPTON, MASSACHUSETTS





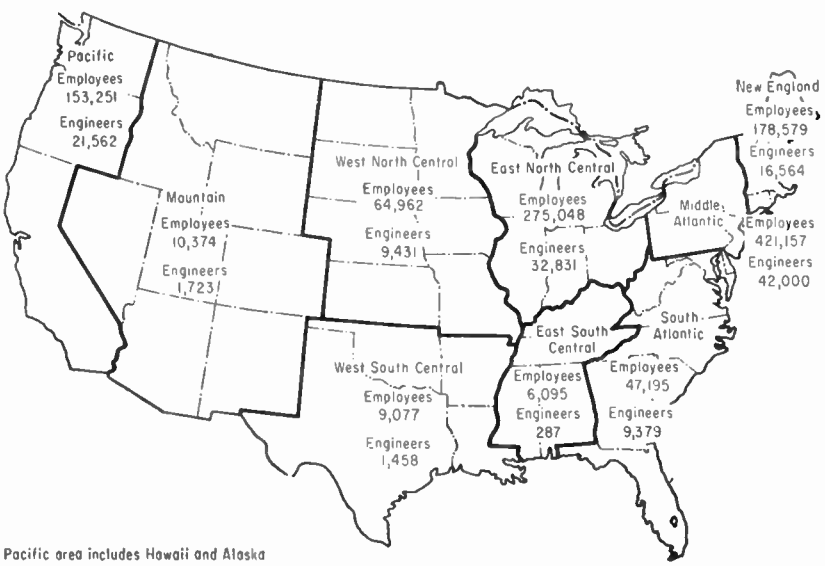
SIZE AND SHAPE *of the industry. Graph A divides the reporting companies into seven size categories; B divides them by the number of engineers employed; C shows the distribution of other employees*

Small Companies Continue to Dominate Electronics Industry

DISTRIBUTION OF MANUFACTURERS BY GEOGRAPHICAL REGION AND ANNUAL SALES VOLUME

Region	Total Firms Reporting	Annual Sales Volume* A	B	C	D	E	F	G	No Answer
New England	799	52	81	79	80	160	46	48	253
Middle Atlantic	1,802	101	162	158	216	338	57	131	639
East North Central	938	46	55	64	85	185	45	106	352
West North Central	177	11	7	15	20	37	8	12	67
South Atlantic	174	11	14	16	24	33	12	18	46
East South Central	24	2	—	3	1	5	—	5	8
West South Central	59	10	8	7	4	10	2	5	13
Mountain	54	8	8	6	4	9	4	2	13
Pacific	820	81	79	78	100	149	38	49	246

* Letters correspond to letters on Graph A



Pacific area includes Hawaii and Alaska

GEOGRAPHICAL DISTRIBUTION *of electronics employees*

Typical company hires up to 5 engineers and 100 other personnel

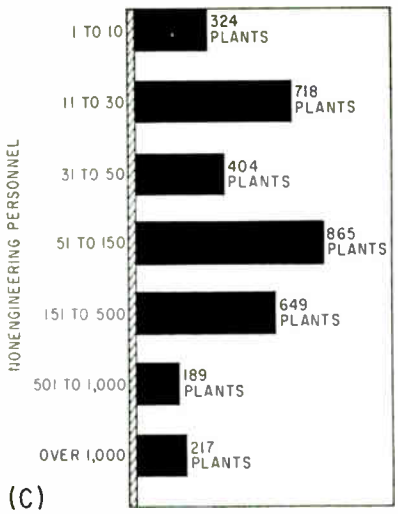
LATEST SURVEY of the electronics industry indicates it is still highly competitive, with small companies far outnumbering large firms.

The typical electronics company has an annual sales volume of $2 million to $2½ million, and has 1 to 5 engineers and about 100 non-engineering personnel on the payroll.

The accompanying illustrations summarize the survey findings. Graph A shows the number of reporting companies in each sales volume range, graph B sizes companies by number of engineers employed and graph C sizes companies by the number of other employees.

The map shows the number of employees and engineers in each of nine geographical regions. The table indicates the total firms reporting in each region and the number of companies in each dollar volume range within each region.

The survey, by ELECTRONICS' Market Services Department, also indicates that the bulk of the industry's manufacturing facilities



are still concentrated in the Middle Atlantic, East North Central, New England, and Pacific Coast states.

New York has the most companies in these volume ranges: $250,000 to $500,000, 79 firms reporting; $500,000 to $1 million, 110 firms; $1 million to $5 million, 163 firms, and over $10 million, 61 firms.

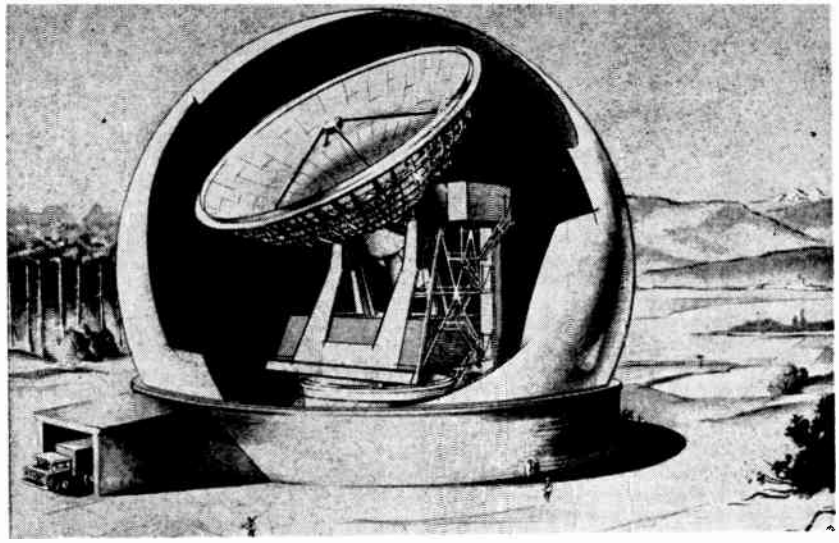
California leads in the following sales volume ranges: up to $100,000 a year, 74 firms reporting; $100,000 to $250,000, 75 firms; $5 million to $10 million, 37 firms.

The survey was planned to provide a picture of the geographical distribution of the industry and its personnel. It is primarily intended as an aid to companies planning regional sales goals and programs. The complete survey provides statistics for each state.

A total of 5,002 companies responded to this year's questionnaire, compared to 4,692 in 1961, 4,398 in 1960, 4,198 in 1959 and 3,982 in 1958.

Big Tower Is Ordered For L-F Communications

ANTENNA TOWER 1,210 feet high will be erected in Lucerne Valley, Calif., for Air Force low-frequency communications program. Tower, triangular in shape and made of galvanized steel, will be built by Dresser-Ideco Inc. for $300,000. Scheduled completion date is January 30, 1963. Antenna is part of Electronic System Division's program to update AF global communications network.



FIRST ANTENNA *at station will be 82 feet in diameter, 66 feet smaller than the horn at Andover, Me. Three more antennas will be built*

Big Dish in the Alps

Germans start building satellite communications station in Bavaria

BONN—West Germany's participation in the Telstar communications satellite program is now assured. The money is available and work on the station's foundation is underway. Germany is anxious to catch up with France, England and Italy.

First transmissions are scheduled for the end of 1963. Plans are now to put four antennas at the station. Two will always be in operation, to provide overlap in tracking satellites. The third will be a standby and the fourth will be used for experiments and modifications.

The station will handle 12 to 60 narrow-band telephone channels and several hundred wide-band channels, and also tv and data-transmission at 1 Gc to 10 Gc.

ANTENNA—The Germans plan to wait for the results obtained with the first antenna before proceeding with the other three.

The four antennas will be laid out in the form of a rhombus with 1,640-foot sides on a valley floor near the town of Raisting on Lake Ammer, 25 miles southwest of Munich. The surrounding Bavarian Alps will reduce interference from the many radio-range beacons in the region.

The first antenna will differ significantly from the horn-parabola types now in use at Andover, Maine, and in France. Gain is expected to compare favorably with the Andover antenna, which is 66 feet larger. The antenna will be a revolving, 82-foot-diameter, parabolic-reflector costing $6½ million.

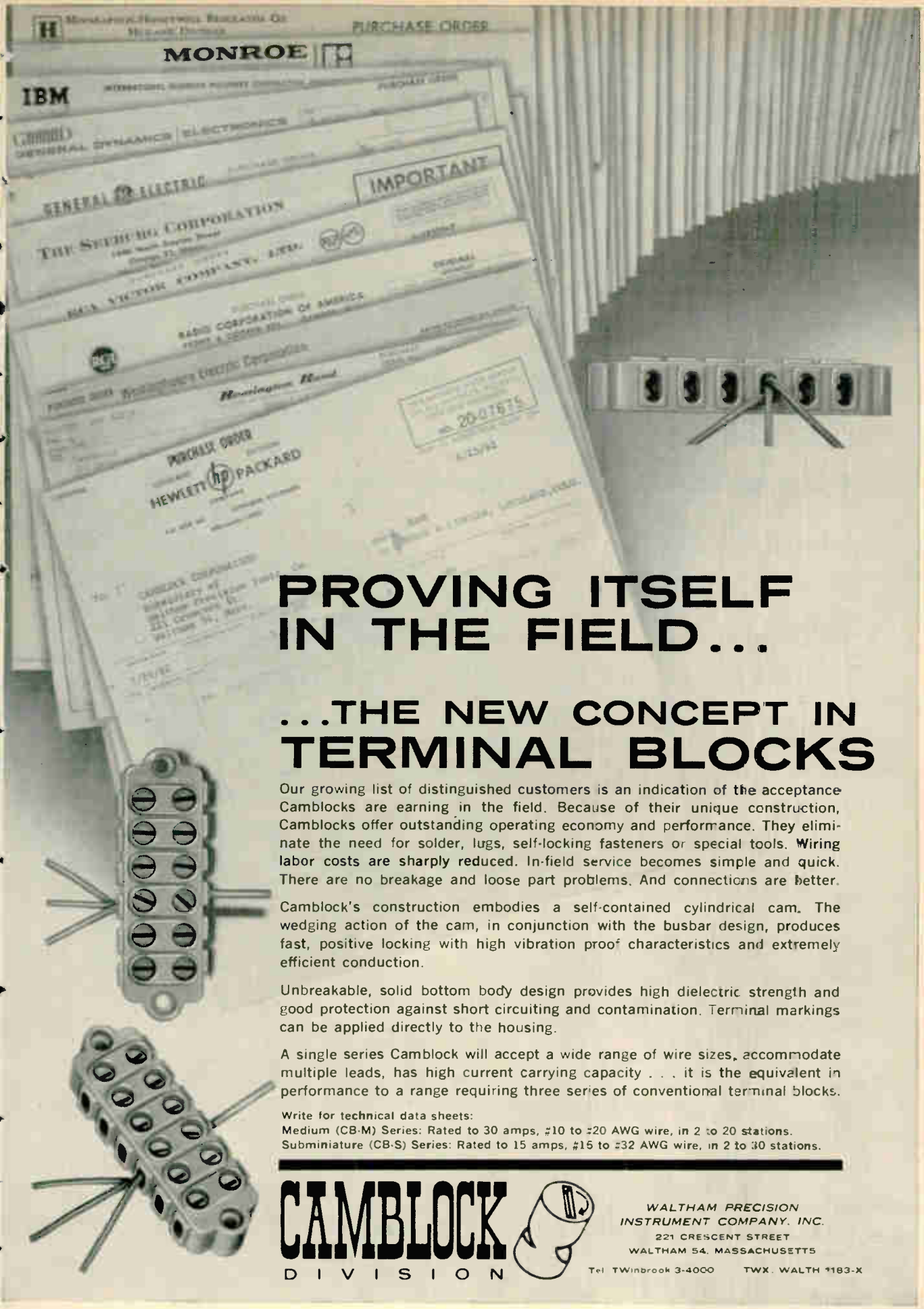
To minimize noise level, distance between the antenna and the receiver input will be kept short as possible. The receiver will be placed in an extension of the rotating axis in the upper control room. Upper and lower control rooms will rotate horizontally with the antenna, but not vertically.

The antenna, being constructed by the MAN Company, of Gustavburg, will weigh 243 tons. Its 158-foot inflated plastic dome will be like Andover's.

EQUIPMENT—The structure will rotate on a 40-foot-diameter hydraulically controlled rail.

Approximately $2 million of hydraulic and other American-developed antenna-control systems will be purchased directly from the U.S. Other U.S. equipment will include helium-cooled ruby-maser amplifiers and an IBM 1620 data processing system. Telefunken and Siemens are to supply remaining electronic components and do all installation work.

The project is being managed by the Central Communications Division of the West German Post Office in Darmstadt.



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Our growing list of distinguished customers is an indication of the acceptance Camblocks are earning in the field. Because of their unique construction, Camblocks offer outstanding operating economy and performance. They eliminate the need for solder, lugs, self-locking fasteners or special tools. Wiring labor costs are sharply reduced. In-field service becomes simple and quick. There are no breakage and loose part problems. And connections are better.

Camblock's construction embodies a self-contained cylindrical cam. The wedging action of the cam, in conjunction with the busbar design, produces fast, positive locking with high vibration proof characteristics and extremely efficient conduction.

Unbreakable, solid bottom body design provides high dielectric strength and good protection against short circuiting and contamination. Terminal markings can be applied directly to the housing.

A single series Camblock will accept a wide range of wire sizes, accommodate multiple leads, has high current carrying capacity . . . it is the equivalent in performance to a range requiring three series of conventional terminal blocks.

Write for technical data sheets:
Medium (CB-M) Series: Rated to 30 amps, #10 to #20 AWG wire, in 2 to 20 stations.
Subminiature (CB-S) Series: Rated to 15 amps, #15 to #32 AWG wire, in 2 to 30 stations.

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MEETINGS AHEAD

SPACE PHYSICS CONFERENCE, American Rocket Society; Philadelphia, Pa., **Dec. 26-31.**

INFORMATION SYSTEMS MEETING, Engineers Joint Council, American Association for Advancement of Science; Bellevue-Stratford Hotel, Philadelphia, Pa., **Dec. 27.**

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

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

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

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

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

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

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

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

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

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

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

OHIO VALLEY INSTRUMENT-AUTOMATION SYMPOSIUM, ISA, et al; Cincinnati Gardens, Cincinnati 2, Ohio, **April 16-17.**

CLEVELAND ELECTRONICS CONFERENCE, IRE, AIEE, et al; Hotel Sheraton, Cleveland, Ohio, **April 16-18.**

ADVANCE REPORT

HUMAN FACTORS IN ELECTRONICS SYMPOSIUM, IRE-PGHFE; *Marriott-Twin Bridges Motor Hotel, Washington, D. C., May 2-3, 1963. Feb. 1 is the deadline for submitting 300-word abstracts to: Rube Chernikoff, Chairman, Program Committee, U. S. Naval Research Laboratory, Code 5124, Washington 25, D. C. All topics within the broad field of development and application of human factors knowledge germane to the design of electronic equipment will be acceptable.*

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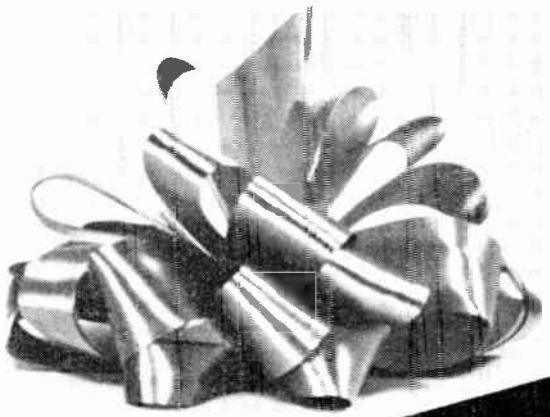

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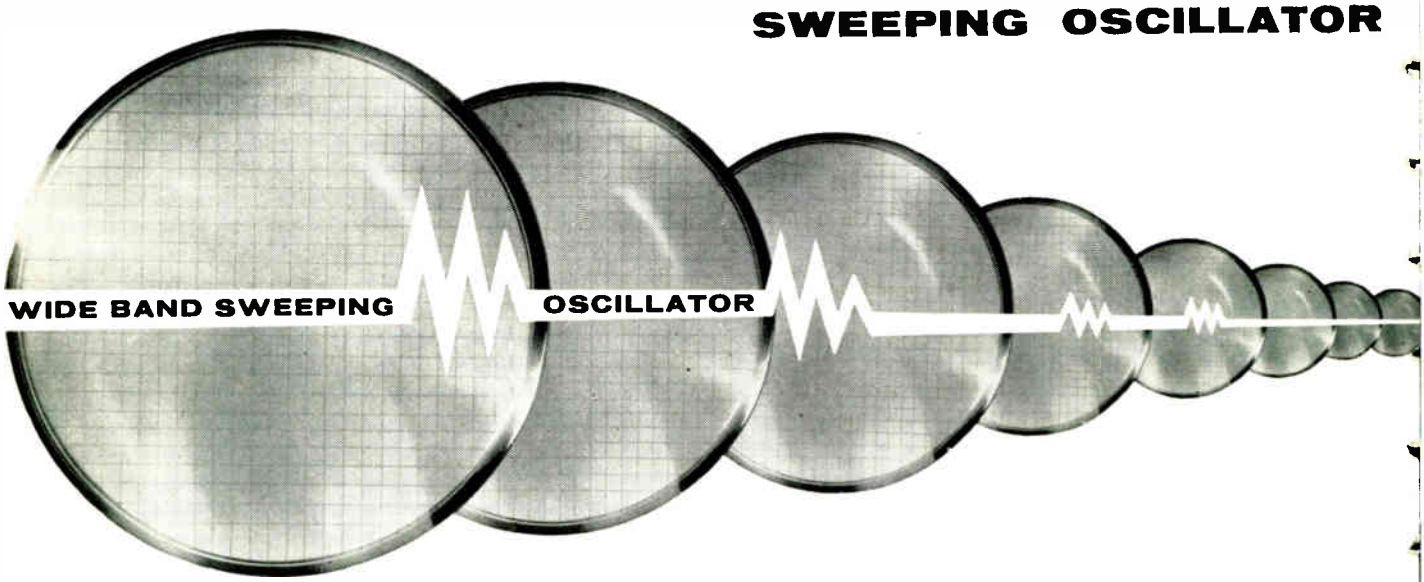
KAY *Multi-Sweep* 121-A, VIDEO-UHF SWEEPING OSCILLATOR



ALL ELECTRONIC

SPECIFICATIONS

UHF Frequency Range: 180 to 1100 mc
Typical Sweep Width: 700 to 1100 mc, 500 to 750 mc, 180 to 220 mc
Output: .5 V rms terminated
Impedance: 50 ohms
Flatness: ± .25 db
Harmonic Distortion: better than 30 db down

VHF Frequency Range: 500 kc to 300 mc
Sweep Width: 500 kc to 300 mc
Output: .5 V rms terminated
Harmonic Distortion: better than 30 db down
Spurious: better than 30 db down
Impedance: 50 ohms
Flatness: ± .25 db
Dimensions: 19⅜" wide x 10⅞" high x 16⅛" deep
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- No mechanical instability and breakdowns
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- Same high RF level at all frequencies
- Clean VHF output
- Provision for external high & low rep rate
- Provision for external frequency markers

Multi-Sweep 121-A is a wide band sweeping oscillator using all electronic circuits to achieve stable swept frequency outputs. It makes use of fundamental and beat frequency oscillator techniques to provide effective frequency coverage in a 300 megacycle wide display. Both center frequency and sweep width are continuously variable. To eliminate phasing adjustment a sawtooth voltage, synchronized with the swept output is available to drive the x-axis amplifiers in the oscilloscope.

The 121-A generates a high level of output over its entire frequency range with a fast acting AGC circuit holding the output constant under all conditions.

The use of all electronic sweep driving and sweep modulating signals provides for maximum reliability and stability of operation at both wide and narrow frequency sweeps.

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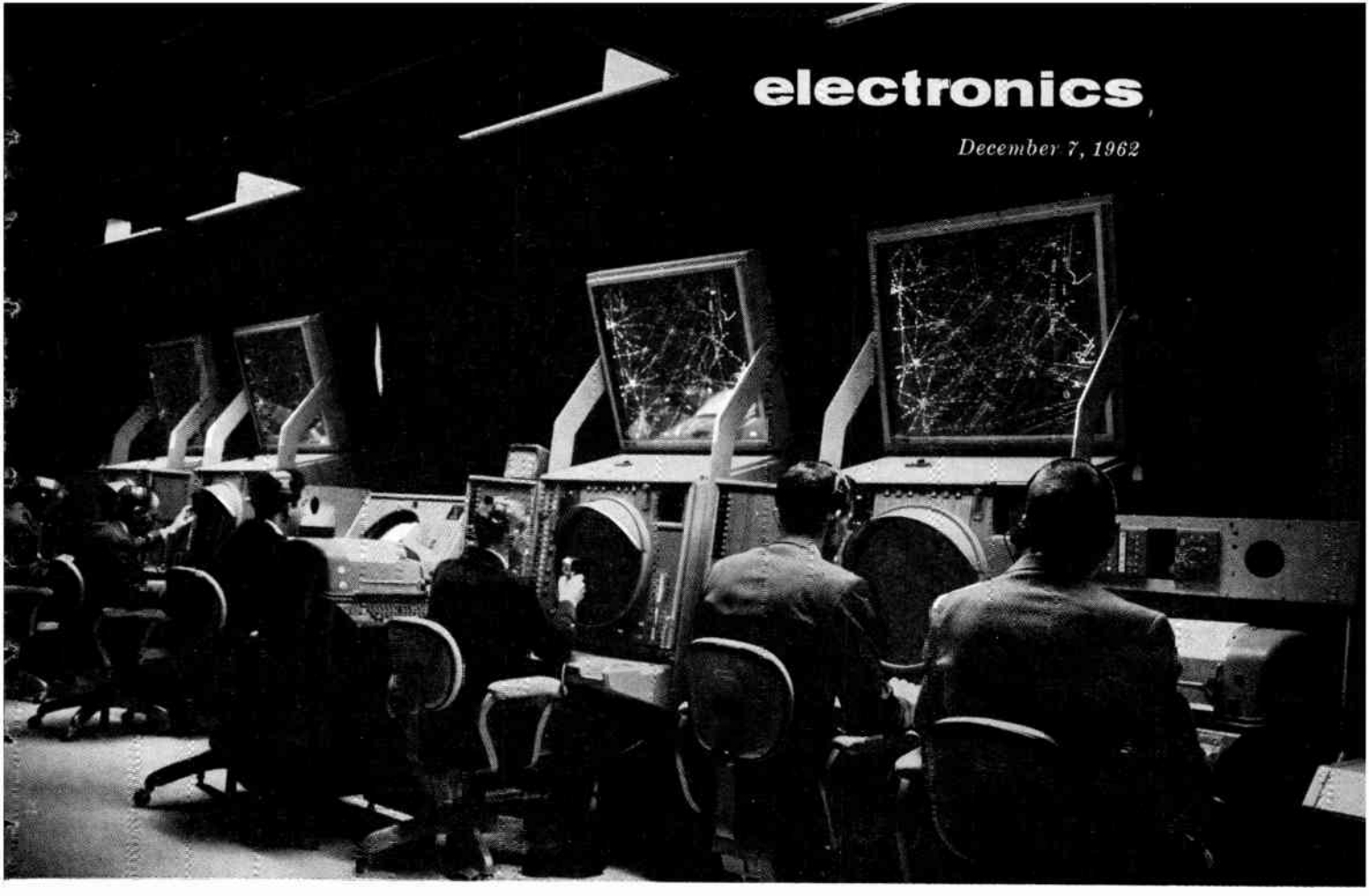
CIRCLE 36 ON READER SERVICE CARD

0.5 TO 1100 MC RANG

electronics
December 7, 1962



TWO CONTROL TEAMS *with a planner in center conduct simulated low-altitude en route control tests at Mitre Corp.'s Boston Air Traffic Control Test Bed, Bedford, Mass. Tests are finished for high-altitude problems*

AIR TRAFFIC CONTROL

TODAY AND TOMORROW

Engineers and scientists are planning a system to handle requirements through 1975. Their job is complicated by the fact that the billion-dollar setup now in use cannot just be thrown away

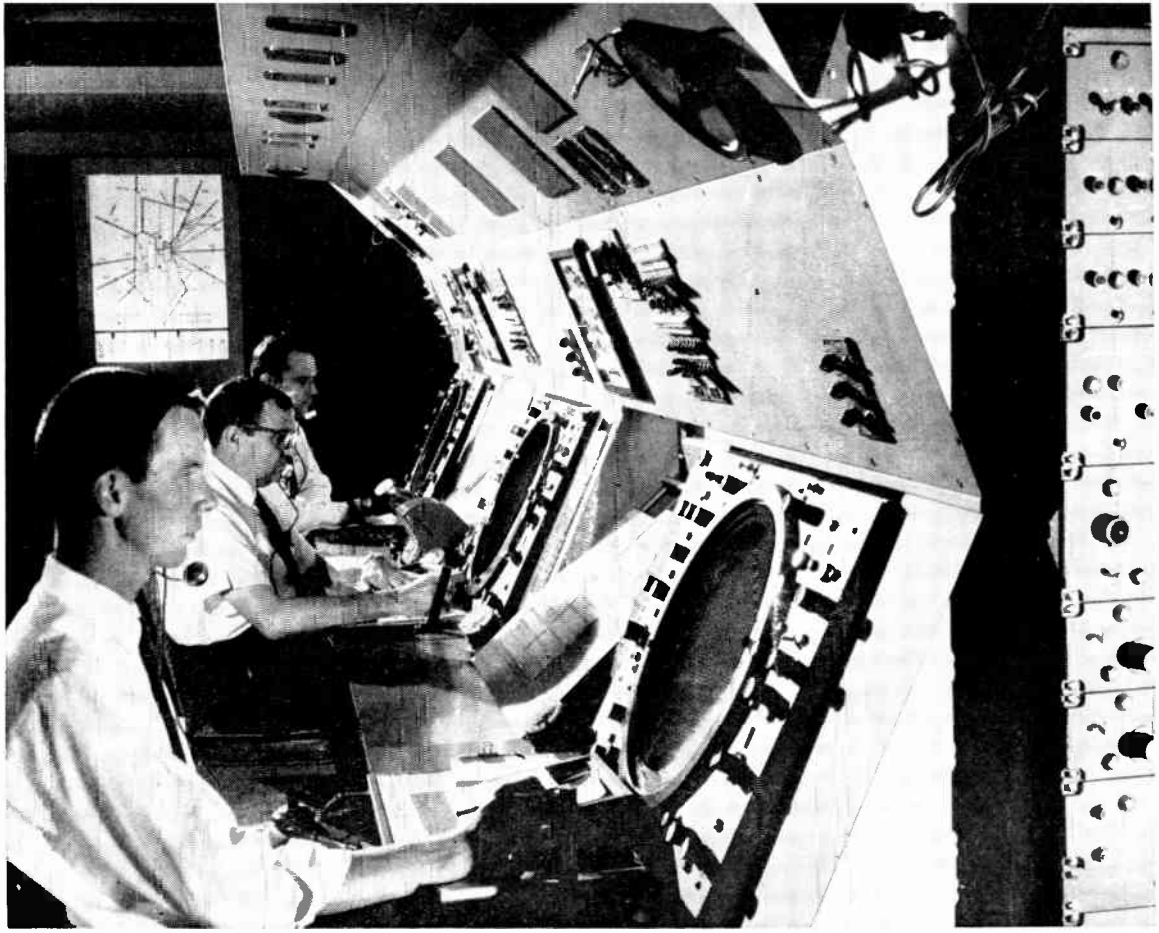
By JOHN F. MASON, Senior Associate Editor

DURING THE YEAR 1975, a fleet of more than 130,000 planes will fly 36 million hours through an 18-mile-high blanket of air over the United States—some of them at velocities twice the speed of sound. Most of this traffic will take place in a thin envelope between 3,000 ft and 8,000 ft above the ground. The jets will by flying above 24,000 ft and supersonic jets possibly above 60,000 ft.

Between now and 1975, a half billion dollars will be spent on an evolutionary airspace utilization system to get these planes where they want to go, efficiently and without collisions.

The system, designed by a 12-man system design team appointed by the Federal Aviation Agency, must evolve from facilities and procedures being used today (existing facilities are valued at $1 billion). New equipment and techniques, which will be welcomed by FAA, will have to fit into the system on a piecemeal basis. The new system should be installed by the end of this decade, and effective through 1975.

To prepare for the future, new techniques and equipment will be evaluated on a continuing basis. The new



REMOTE SITE *displays for Texas Instruments ASR-4 offer operator choice of three modes of video presentation: normal radar video only, moving-target indication or both*

facilities to test the agency's system design will be a breadboard laboratory model, scheduled for readiness in 13 months (ELECTRONICS, p 26, Sept. 14). Headquarters for this test bed—not to be confused with prototype equipment—is at FAA's National Aviation Facilities Experimental Center (NAFEC), near Atlantic City, N. J. Located in the midst of the high density air traffic areas of New York, Philadelphia and Washington, NAFEC is a surprisingly tranquil, and even beautiful reservation. Its 6,000 acres of pine trees contain three of the most heavily instrumented runways in the world, a measurement range, R & D equipment and 223 active projects—53 in the evaluation division, 80 in the experimentation division, and 90 in the research division.

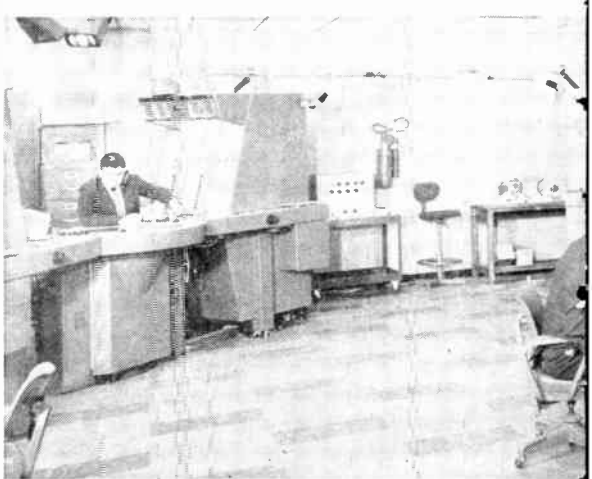
One important tool at NAFEC is the Computer Driven Simulation Environment. The CDSE, consisting of an IBM 7090 computer, displays, on-line printer, card reader, card punch, magnetic-tape units, keyboard data entry system and communications, is used to make operational feasibility studies of man-machine techniques for

SIZE AND SHAPE OF MARKET

Cost of the National Airspace Utilization System is expected to hit $12 billion by 1975. Total R & D appropriation for fiscal year 1963 is $63,159,000; for facilities and equipment, $125 million.

Two-thirds of the R & D money ($44.572 million) will go for air traffic control and navigation: $4.670 million for aviation weather networks: $8.755 million for aircraft safety: $3.286 million for airports: and $1.876 million for aviation medicine.

Although FAA has not yet decided where to cut the $10 million Congress cut from the overall facilities and equipment request, major items in the shopping list will still be: Vortac, terminal area radar, tower facilities, and long-range radar



ENGINEERING MODEL *at NAFEC, Atlantic C sition-area console (left) transfers an aircraft to a te (right) monitors aircraft in its glide-slope. Data-e*

use in the terminal areas. Decisions made with the CDSE will result in breadboard hardware for installation in the NAFEC engineering model. Similar studies for the en route areas are being carried out by the Mitre Corp.

Here, and in two succeeding articles, is what the design team wants, and doesn't want, in data processing and display, radar, navigation, communications and weather forecasting equipment.

DATA PROCESSING AND DISPLAY—Heart of the ATC portion of the airspace utilization system will be data-processing and display systems. This new equipment will permit the system goals of flexible sector assignments, larger sector areas, more aircraft under each controller, lower pilot-controller communication workload, and fewer frequency changes for the pilot.

How computers and displays can best accomplish these goals, and what kinds of equipment they should be, are not known at present. According to Joseph D. Blatt, Director, Systems Research and Development Service (of which NAFEC is a part), by the time NAFEC determines performance requirements and specifications there will probably be an operational computer system that can do the job. Until specifications are known, however, it would be misleading to name existing data processing systems as possible candidates, Blatt said.

Work to come up with requirements is now underway at NAFEC's experimentation division where a variety of computers, consoles and display and other equipment is being tested. A large portion of the test bed is the ATC data processing central—originally built by General Precision, Inc. under a 1958 FAA contract as the prototype for an operational system. Although the central does not fulfill all the requirements of the new system design, it will provide a valuable tool for determining what kind of equipment will be needed.

The computer riding herd on this experimentation is an IBM 7090 with a 7281 transmission device to connect the computer with the input and output equipment. The 7090 will eventually come up with the ideal design specifications for a data processing system.

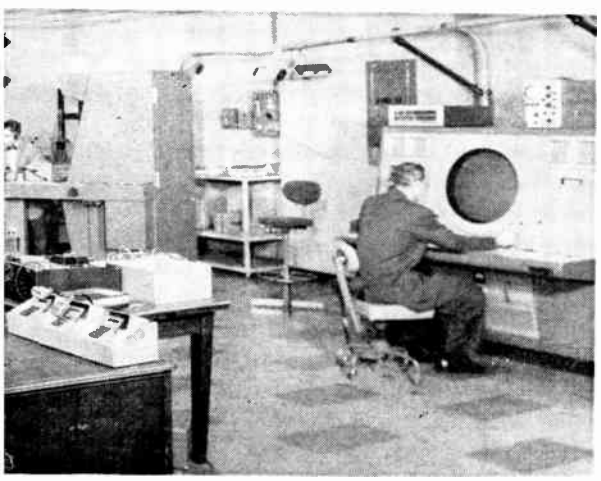
SYSTEM REQUIREMENTS—The system spelled out in the design team's report (Fig. 1) will be required to: perform the controller's routine and clerical tasks; gather data, organize, process, correlate and filter it, and give the operator what he needs; plan the air traffic flow; give the controller either a plan view display or a tabular display of the controlled traffic. It will also provide for communicating with the machine to call up specific items of information and to exercise control and transfer actions. It must monitor the air situation, interpret changes, and warn of dangerous situations before they develop. It watches the controller to prevent him from doing something wrong or failing to do something he should. In addition, the data processor will maintain a legal history with a playback and data-reduction capability.

IMPLEMENTATION—Development and installation of equipment to perform these sophisticated tasks will proceed in an evolutionary, building-block manner. This approach promises several advantages: early improvement of the existing system, feedback of design corrections for development of the overall system, flexibility to provide each center with its particular requirements, with add-on capability as the traffic density grows.

Although a general-purpose computer is more expensive than a special-purpose type, a special computer can not be designed until performance requirements are known. For this reason, a general-purpose computer will be used. To cut the cost of the big machine, a specially designed computer may be used with the big computer for certain functions, such as automatic tracking, which require high data rates for processing. Besides lower cost, this arrangement provides an added measure of reliability: if the special machine fails, the general-purpose computer continues to operate.

To provide continual operation of the system during maintenance, a duplex computer configuration is planned. The degree of duplexing will probably vary in each center, based on traffic density.

AUTOMATION LADDER—Degree of automation introduced into the system will increase step-by-step. By 1975, the data-processing system will be able to check the man and call to his attention situations that require



J., will test new concepts of the system design. Tran-l area console (center rear). Precision approach radar sole is in center (General Precision, Inc.)

WHAT THE INITIALS MEAN

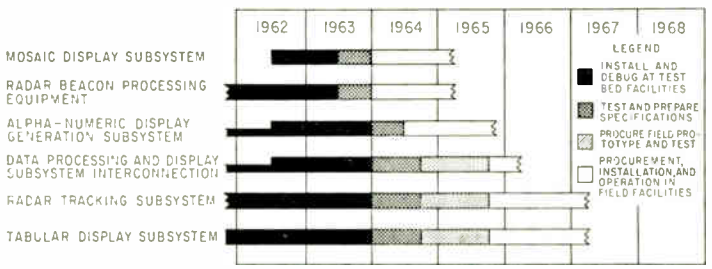
ARTCC—Air Route Traffic Control Center
ASDE—Airport Surface Detection Equipment
ASR—Airport Surveillance Radar
ATC—Air Traffic Control
ATCRBS—Air Traffic Control Radar Beacon System
ATE—Altitude Transmitting Equipment
CDSE—Computer Driven Simulation Environment
FAA—Federal Aviation Agency
GAT—General Aviation Transponder
IFF—Identification Friend or Foe
IFR—Instrument Flight Rules
MOPTAR—Multi Object Phase Tracking and Range
NAFEC—National Aviation Facilities Experimental Center
NORAD—North American Air Defense Command
NOTAM—Notice to Airmen
RATCC—Radar Air Traffic Control Center
SAC—Strategic Air Command
SAGE—Semiautomatic Ground Environment
SLATE—Small Lightweight Altitude Transmission Equipment (or transponder)
SLS—Side Lobe Suppression
TACAN—Tactical Air Navigation
VFR—Visual Flight Rules
VOR—VHF Omnidirectional Range
VORTAC—VHF Omnidirectional Range colocated with TACAN

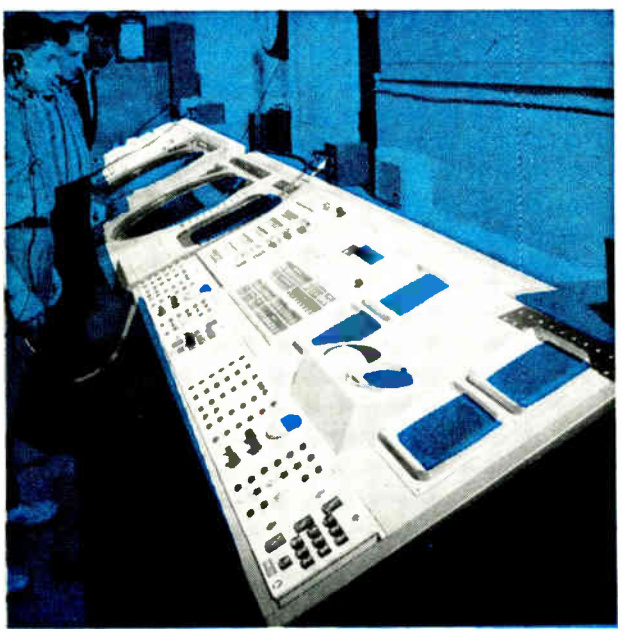
KINDS OF R&D CONTRACTS AWARDED BY FAA

Type of Contract	Number	Percent of Funds
Cost Plus Fixed Fee	210	70
Fixed Price (R&D, studies or services)	322	12
Fixed Price (supply and equipment)	590	9
* Incentive	7	7
Cost Type	12	1
Other (maximum price, time and material, etc.)	9	1
Total	1,150	100

* Although only 7 percent of the funds obligated for R&D contracts since Aug. 1957 were incentive contracts, the trend is moving in this direction

PROGRESSIVE IMPLEMENTATION PLAN FOR THE ATC SUBSYSTEM





CONTROL TOWER *display to be used in NAFEC's engineering model consists of a 1,000-line tv display for tabular information on departing aircraft, airport surveillance radar (ASR) display using alphanumerics, and airport surface detection equipment (ASDE) display. Communications and weather equipment are in foreground*

control action. The next two steps in the ladder toward optimum automation will be implemented when cost/benefit analyses show they are practicable: (1) the computer helps the controller make decisions by recommending specific control actions and (2) it institutes flow control on a center (and later nationwide) basis.

Plan to reduce the number of centers in the country, and enlarge the individual sector each controller will handle, creates new demands on equipment. The computer at the control center must store radar data from en route sites; it must be capable of automatic tracking at some, if not all, centers. To increase sector size, composite radar displays will be used.

Other en route controller functions the computer will handle are flight plan updating, air traffic flow planning, conflict prediction, radar handoff.

Terminal area computation may be handled by separate equipment at the control center; it might be a portion of the center computer itself; or it could be remotely located at, or near, one of the airports. Use of many small computers would be helpful in automating low traffic density areas sooner because of the lower cost and simpler performance requirements. Final decision between large and small computers will probably be on an area-by-area basis.

Terminal area computers and displays will aid the marshalling, arrival planning, sequencing, final spacing (approach), departure control and planning.

DATA DISPLAY—To avoid delay in getting display gear into operation, FAA plans to use existing, modular-type equipment and known techniques. At the same time, an intensive R&D effort will continue.

The display system uses tabular displays to replace flight progress boards and to present computer-generated flight-plan data and control orders.

A simplified pushbutton data-entry system will allow the controller to talk to the computer. Cathode-ray-tube displays at each active control position will present a plan view of the controlled traffic, including aircraft position, derived from radar or flight-plan information and alphanumeric data.

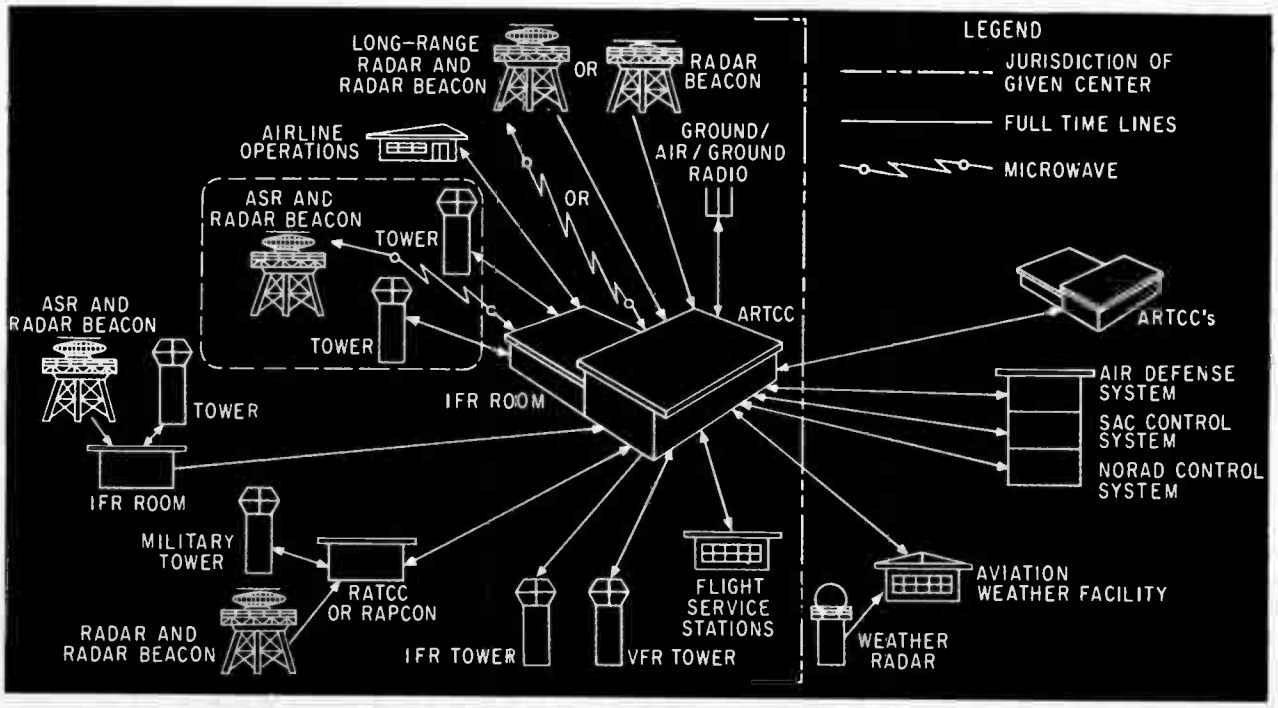
How big radar displays will get depends on experimentation now underway at NAFEC. There are advocates of displays that represent coast-to-coast air routes. Radar data would be transmitted across country by microwave to a center. This would enable one controller to handle one aircraft throughout it's trans-U. S. flight. The Theatre Network Television Corp. is supplying a large-screen Eidophor tv-projector system to NAFEC for testing.

From the controller's point of view, however, smaller displays provide a more personalized contact with the pilot whose destiny he is directing. Also, he can manipulate the display to suit his needs.

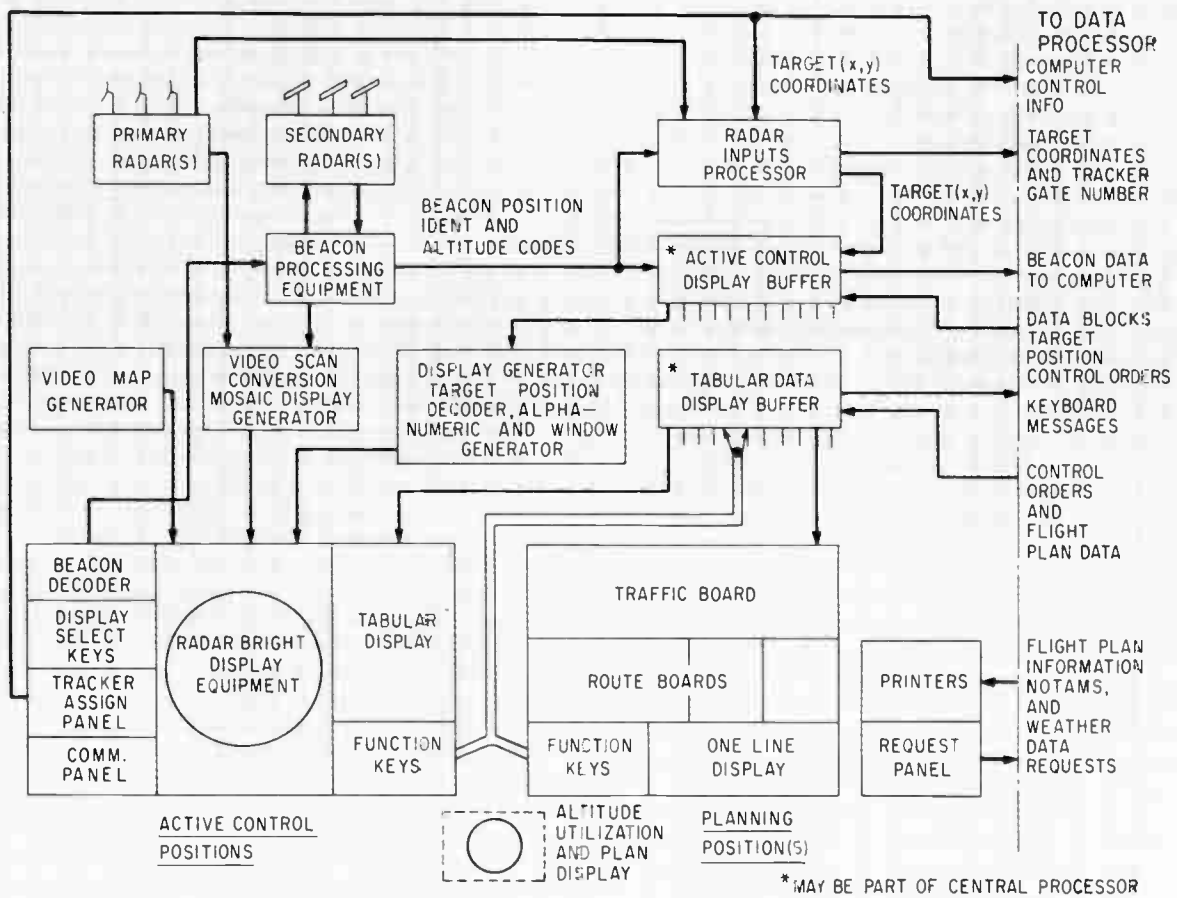
There will be several special types of tabular and printer-generated displays for flow control, weather sequence, local weather, NOTAM, and facility status.

Each active controller's position will be equipped with a bright, flicker-free, tv-type display that presents a plan view of the controlled traffic with alphanumeric identity, altitude, handoff symbols and computer-generated control order information. The tower will use an ASDE display for monitoring the runway traffic.

The display system configuration (Fig. 2), selected



AIR TRAFFIC CONTROL *environment will evolve according to development and production schedules and traffic requirements of particular areas—Fig. 1*



DISPLAY SYSTEM *configuration reveals extensive automation. Design is open to new display techniques—Fig. 2*

BEACON VIDEO *processor, built by Burroughs, uses light gun to identify aircraft and display altitude. Device is now under test at NAFEC*

by the design team, must provide certain basic capabilities:

To make section assignments flexible, the tv technique of taking portions of scan-converted pictures from two radars and combining them in mosaic form was selected. According to the design team, computer-generated tracks and composite data of the SAGE type are not as satisfactory for ATC as actual radar presentations due to loss of accuracy in computer handling.

Other design considerations include: independent channels to the display for video and computer-processed information for reliability; modular design approach for flexibility: retention of scan conversion equipment to present data on a bright, flicker-free display; provision of a buffer store and display generator to provide computer-generated data in a form compatible with scan-converted radar data; composite display to show both flight plan and radar track; provision for continuing display of computer-generated information after the computer fails; and pushbutton coordination with other controllers.

IMPLEMENTATION PLAN—Six equipment installation programs will be carried out sequentially: (1) mosaic display subsystem—primary and radar beacon video-scan conversion and radar bright display gear will be modified to include the synchronizing and blanking circuits to generate mosaic displays; also, the joystick video marker will be installed. (2) radar beacon processing equipment—ten channel decoder type equipment will be installed along with modification kits to provide decoding capability for 4,096 identity codes; altitude decoding, digital readout of beacon code, altitude, and plan-position coordinates for display generation. (3) alphanumeric display generation—controller displays will be modified for off-centering and scale-expansion controls for mosaic display; active control display buffer and the display generator will be added; a keyboard will permit association of aircraft identities with specific beacon codes. (4) interconnection of the data processing and display system —extrapolated flight plan position and alphanumeric data can be displayed. (5) radar tracking subsystem—will be installed. (6) tabular display—this subsystem will be installed last due to the need for more development work plus the fact that it is a completely new subsystem. The system will include central tabular data display buffer, flow control and planning console, and the displays located at each active control position. Implementation will also include the computer interconnection, the interconnection of the joystick reporting system with tabular message generation system, the removal of flight progress boards, installation of remoting equipment to transmit tabular display data to the tower cab and IFR room if located remotely from center facility.

RADAR—Primary (skin-tracking) radar, and secondary radar (interrogator and airborne beacon transponder) will be used through 1975 for determining aircraft position in three dimensions, identity and perhaps other flight data.

This information will be derived independently of the pilot's navigation gear, and will not require voice communication between the aircraft and controller.

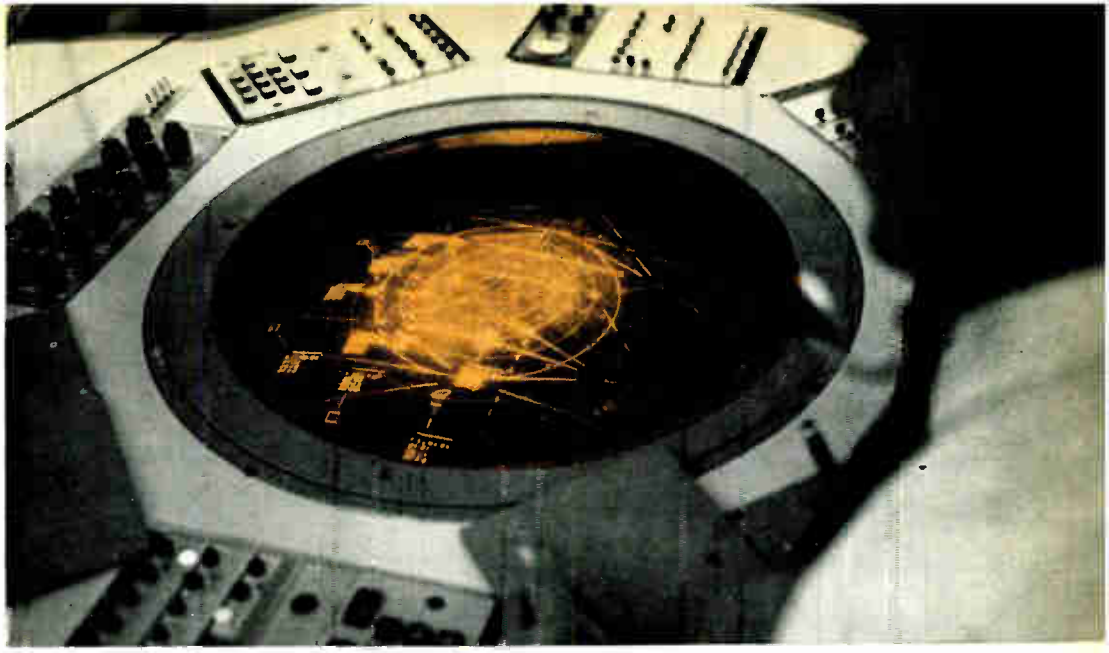
Airport Surveillance Radar (ASR) will continue to be used as the primary data acquisition source in the busier airports. An Air Traffic Control Radar Beacon System (ATCRBS) interrogator will also be used with each ARS to acquire the aircraft identity and height data on those planes equipped with transponders.

Eventually, FAA would like to acquire this data by secondary radar only, and get rid of the big, expensive en route primary radar units. Unresolved technical, economic and political problems involved in such a step, however, assure the use of primary radar for some time to come. FAA believes the ATCRBS technical problems —capacity, reliability and interference by other equipments—can be resolved. Improved decoders can increase the number of transponders being interrogated at any one time. Reliability already compares favorably with many other equipments in the system. Interference problems with VORTAC and high-powered IFF gear are not insurmountable.

High priority work will continue on small lightweight altitude transmission equipment (SLATE) for mass production at a reasonable price for general aviation users.

Air carriers now have a beacon transponder offering 64 codes. Needed is ATE (altitude transmitting equipment)—a transducer that receives its input from the altimeter system and converts mechanical motion into digital information, which is then transmitted by the beacon. Besides addition of ATE, the airline program will require conversion of the beacon to 4,096 codes.

GAT, the general aviation transponder, is similar to



PLAN-POSITION *data-display console, built by General Precision, Inc., uses a horizontal 21-inch direct-view storage tube supplied by Hughes. Console displays primary radar, beacon data, computer-generated track-while-scan and alphanumerics*

the air carrier beacon. With the addition of ATE, it too, will satisfy all en route and terminal area needs.

R & D—Development work now planned on ATCRBS includes: 3-pulse side lobe suppression (SLS), storage tube defruiting, beam sharpening and target center marking, emergency code automatic monitoring decoders, and SLS switching equipment.

On the ground, relay transmission, decoding and display equipment for ATCRBS will be developed and installed as quickly as possible. Ground processing and display gear will be operational at some sites by late 1963.

Plan to use beacon transponders has not killed interest in improved, and even new primary radar techniques. There is tremendous interest in the development of new radar for terminal areas. Need is for a faster rate of data acquisition from a large number of aircraft. This calls for increased coverage and rate of scan, and finer resolution over bigger areas. Hemispherically swept, electronically scanned phased array radars would provide improved performance. Johns Hopkins University's Applied Physics Laboratory is building such equipment now for the Navy. Frequency scan is also promising, although at the moment it doesn't seem to have sufficient advantage to scrap existing radars. And stacked beam radar is being considered.

For the time being, FAA will concentrate on techniques for improving radar target definition and detection probabilities: lower and higher coverage for a single site; minimizing interference between radars and susceptibility to electronic countermeasures; and improved methods of data transfer.

Improvements planned for existing radar include: parametric amplifiers (Airborne Instrument Laboratories' new parametric amplifier has extended the range of the ASR-2 radar by 75 percent), and improved radar receiver immunity to external interference.

At centers and in some terminal areas, the inputs from more than one primary radar and beacon interrogator will be netted together to provide increased overlapping area coverage. Also, data from Air Defense radar will be remoted to FAA centers, and in some cases, the military radar relocated.

3-D RADAR—Opinions are mixed about ground-based height-finding radar. The design team concludes that 3-D (three-dimensional) radar is limited by practical, technical and economic considerations to relatively short range terminal area type use. "Of the various height-finding radar techniques, a passive receiving system using the ASR as the illuminator offers somewhat better resolution than other known efforts." The Maxson 3-D radar installed at NAFEC will continue to undergo tests.

LONG-RANGE RESEARCH—NAFEC's research div. is studying other types of data acquisition subsystems on a long-range research basis as possible candidates for future replacement of primary radar and ATCRBS. These include: airborne synchronized time standard automatic position reporting; a hyperbolic system; an interferometer system—one project uses a converted MOPTAR; networks of direction finding stations—a multi-theta technique, equivalent to VOR in reverse; and a multi-rho technique—two radars with a known base line.

For over-water systems, the University of Michigan is working under contract to NAFEC. Possibilities include an over-the-horizon radar technique like Navy's Teepee and low frequency hyperbolic systems that provide ground waves. To date, NAFEC sees no good possibilities for over-water systems independent of pilot cooperation.

ASDE—Airport surface detection equipment research is needed, the design team says. While use of the existing K-band radar partially fulfills the requirements, radar as a technique has serious limitations for this application. More suitable would be sensing devices along the runways and taxiways that generate a display for the controller.

Unfortunately, the design team reports, there are no such devices under development that are wholly satisfactory. Until a solution is found, radar will continue to be used, with an improved daylight radar display.

FIRST *of three articles. Subsequent articles will cover navigation, communications and weather*

UNIQUE TWO-CHANNEL

Inaccessability of some rotating parts prevents speed measurement

on the part can be detected more than a foot away, and the speed

By R. R. BOCKEMUEHL
P. W. WOOD
General Motors Research Laboratories, Warren, Michigan

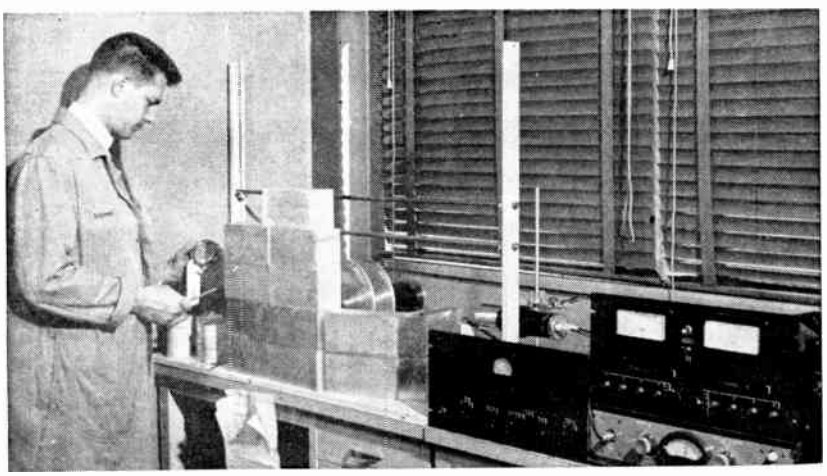
WHY USE RADIOISOTOPES?

Certain types of fluid-coupled transmissions and other turbine systems have rotating parts that are not coupled directly to input and output shafts. These rotating parts are often sealed in metal housings that prevent measurement of their speed by conventional techniques. Such a problem can be solved through use of radioisotopes. This system can measure the speed of two adjacent rotating parts with a detector located more than a foot away from their quarter-inch steel housing

GAMMA RADIATION is used in this tachometer because of its ability to penetrate dense materials. The average rate at which gamma photons are detected is proportional to the inverse square of the distance from the radiation source to the detector. A gamma radiation source is located on the periphery of the rotating part and the detector is situated so that its distance from the source varies with the angular position of the part. The detector output is a series of randomly spaced pulses, whose average repetition rate depends on the angular position of the part, and whose amplitude depends on the energy of the detected gamma photons. The average repetition rate cycles through a maximum and minimum value for each revolution of the part, but the pulse amplitude remains constant.

Rotational speed of two adjacent parts can be measured with the system shown in A. Radioactive source *A* is selected to emit higher energy photons than isotope *B*. Output of the detector consists of two superimposed pulse trains having differing amplitudes, and an average repetition rate that is modulated by the rotation of the respective parts. The detector output is amplified and coupled to two pulse amplitude discriminators, one of which is adjusted so that it triggers only on the higher amplitude pulses generated by source *A*. The discriminator output is demodulated by an averaging circuit that produces a voltage proportional to the short period average of the pulse repetition rate, and corresponding to the angular position of part *A*.

The other discriminator is adjusted so that it triggers on pulses generated by both sources *A* and *B*, and the output voltage of the associated averaging circuit corresponds to the sum of the pulse rates from both sources. The signal corresponding to the *A* channel is



AUTHOR WOOD *at test setup, which includes, left to right: motor-driven test wheels containing the isotopes, scintillation detector above the demodulator, dual ratemeter and scintillation detector supply, and motor control*

TACHOMETER Uses Radioisotopes

by ordinary methods. Gamma radiation source, placed

then measured with conventional circuits

subtracted from the combined signal by a differential amplifier, and a waveform whose frequency corresponds to the speed of part *B* is produced.

Each revolution of parts *A* and *B* generates two output signals of one cycle each, which can be converted to rpm indications by conventional frequency measuring circuits.

LIMITS—The random nature of the isotope disintegration produces fluctuations in the short period average of the pulse repetition rate even though the parts are stopped. This imposes a lower limit on the speed measuring range. This limit is reduced by using a more active source. Source activity is limited by safety considerations and by the frequency capability of the electronic circuits. A speed range of 400 to 6,000 rpm was obtained by using 2 millicuries of cobalt-60 for source *A* and 6 millicuries of cesium-137 for source *B*, with gamma photon energies of 1.33 and 1.17 Mev for cobalt-60 and 0.66 Mev for cesium-137. The radioactive source can often be imbedded in a special part that replaces a standard bolt in the rotating assembly. Note that use of these amounts of radioactivity require special permission of the Atomic Energy Commission.

Conventional vacuum-tube circuits are used throughout the system. The detector is a two-inch sodium iodide scintillation detector. High-speed trigger circuits with adjustable bias networks and cathode-follower outputs serve as amplitude discriminators (B). The averaging circuits are the linear diode pump integrator type with cathode-follower feedback.[1] These are followed by sharp 200-cps low-pass filter amplifiers. The difference amplifier is a cathode-coupled duotriode. Output indication is provided by either a commercial count-rate meter or a digital frequency counter.

Circuit servicing and discriminator adjustment is facilitated by the simple but unique test generator (C). This consists of a free-running multivibrator, half of which is also connected as a Colpitts oscillator.[2] The output is a 1-Mc sinewave, 100-percent modulated by a 15-cps square wave, which serves as an idealized analog of the detector output. This circuit can also be constructed with both halves connected as r-f oscillators tuned to different frequencies; the output is shifted from one frequency to the other at the multivibrator repetition rate.

The speeds involved, from 0 to 6,000 rpm, required the use of logarithmic scales on the dual rateme-ter, which was built for this application. The logarithmic scales give better resolution than linear ones on both the high and low ends.

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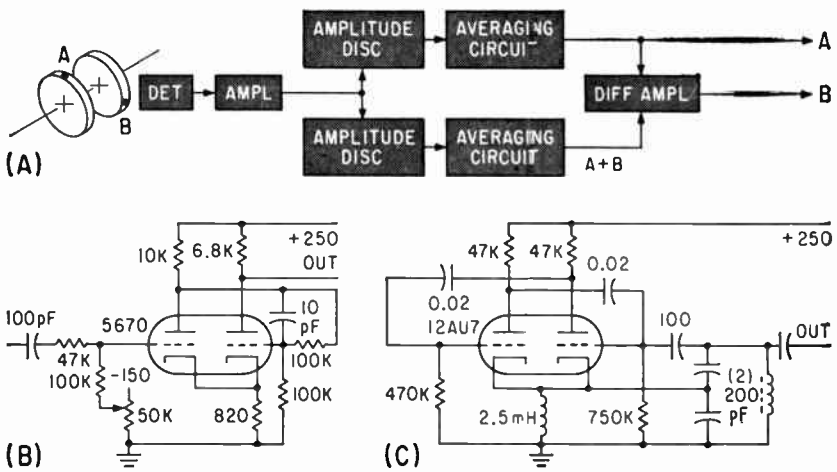
(1) C. H. Banthrop, *Electronic Eng.*, 26, 110, 1954.
(2) P. W. Wood, U. S. Patent 3,034,070.



TACHOMETER SYSTEM *(A) converts the detected speed information into two separate analog signals; amplitude discriminator (B); test circuit for servicing and adjustment (C) combines a multivibrator with an r-f generator*

Why Use Silicon

By LUCIEN J. THERIAULT
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Transformer Section,
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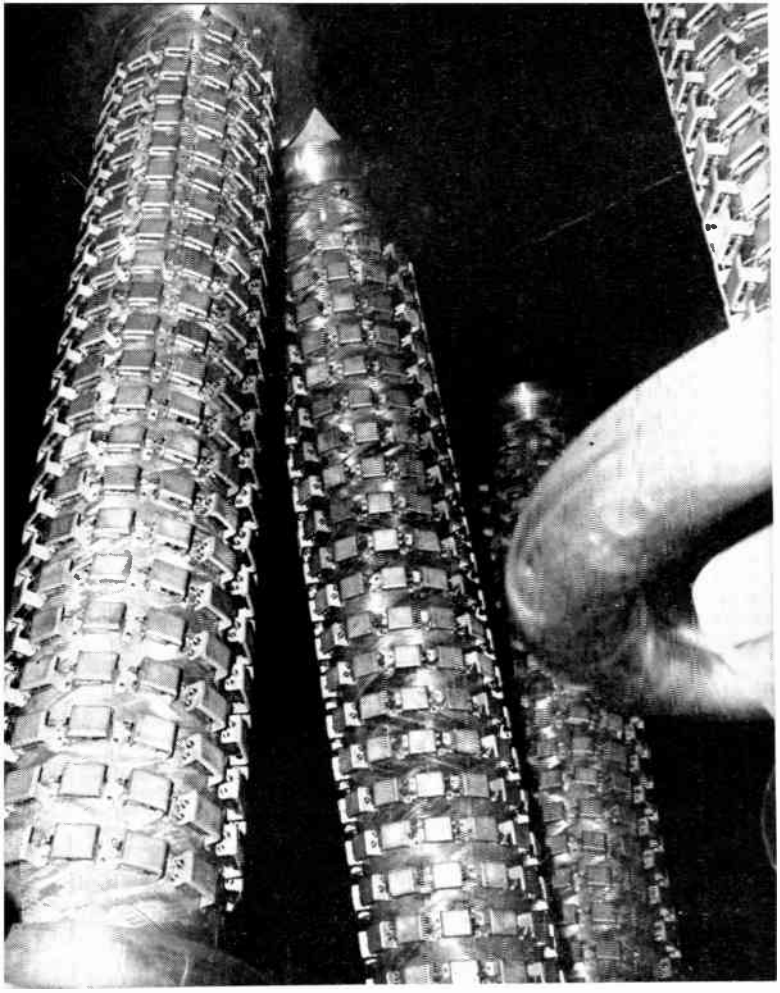


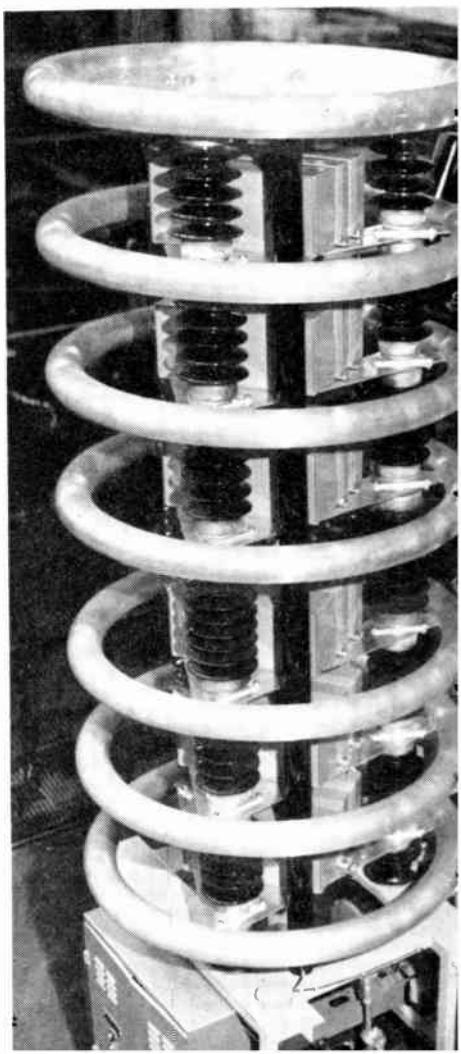
INDIVIDUAL *rectifier diodes are spiraled around these 6-foot 10-inch-diameter pillars to provide a d-c source of 150/89 Kv at 4/6.8 amperes*

WHEN THE APPLICATION is fully understood, solid-state devices can be assembled for practically any voltage and current. Single diode assemblies can now be constructed for currents ranging from a few milliamps to over 200 amperes per conducting path; they can also be paralleled for even higher current capabilities.' Unlike high voltage rectifier tubes, which come in discreet voltage and current steps, the solid-state rectifier has great flexibility and allows the engineer to design equipment that can be tailored to any application and in a wide range of physical shapes.

In very high voltage systems, where the complexity of supplying high voltage tubes with filament

A TECHNOLOGICAL QUANTUM JUMP

Strings of silicon diodes assembled into high-voltage rectifiers have come into wide use in the last three years. Now single silicon rectifier diodes come with peak-inverse voltage ratings up to 2,000 volts, and with currents in the ampere range. It doesn't take many such diodes to build up a formidable rectifier stack. Even with less exotic silicon units, designers can often get a better combination of current-carrying capacity and piv rating using a silicon diode than with selenium or copper-oxide elements



HIGH-VOLTAGE *Cockroft-Walton power supply for particle accelerator delivers 600,000 volts d-c. Diodes and surge-limiting resistors are mounted in oil-filled cylinders criss-crossing between stacks*

Rectifiers For High-Voltage Service?

Peak inverse voltage ratings of individual rectifier diodes has been pushed up to where a series chain of diodes can compete with vacuum-tube and mercury-vapor rectifiers

power makes the system costly, the solid-state device has advantages.

Moreover, a large percentage of individual solid-state elements can fail by short-circuiting before actual failure of the high voltage rectifier assembly occurs, hence reliability is much higher than for a single tube element.

SOLID STATE VERSUS TUBES—In selecting a solid-state versus tube rectifier for an application, consider these factors:

(1) The solid-state rectifier will generally have a lower forward voltage drop than an equivalent vacuum-tube rectifier but it will generally have a higher voltage drop than a mercury-vapor tube.

(2) The lower temperature of the solid-state rectifier plus its inherent reliability allows its use in sealed oil packages as well as in air.

(3) With proper packaging, the solid-state rectifier in oil generally requires less space than is required for a vacuum tube plus filament supply.

(4) The solid-state rectifier has low forward resistance and has no inherent current-limiting action like the current-emission limit of a vacuum tube. Consequently, its protective equipment must be carefully designed.

(5) Silicon rectifiers are less able to withstand overvoltages than vacuum-tube rectifiers.

(6) Unlike high voltage vacuum and mercury-vapor tubes, a silicon rectifier assembly can be formed in almost any shape and to almost any degree of ruggedness to withstand the rigors of military specifications.

SILICON VERSUS SELENIUM—Considering the use of silicon versus selenium rectifiers, observe the following considerations:

(1) For the same peak inverse voltage (piv) capability, the silicon rectifier will have 1/2 to 1/20 the forward drop of a comparable selenium rectifier.

(2) The silicon rectifier assembly has no aging characteristic and does not require additional voltage capability to compensate for increased forward drop resulting from aging. Both forward and reverse losses will be reduced with silicon rectifiers, making it much easier to cool the equipment.

(3) Except in low current devices, the silicon assembly will be much smaller than the equivalent selenium assembly.

(4) The lower shunt capacitance and higher inverse resistance of silicon diodes requires them to be paralleled with shunting elements when used in high voltage series rectifier assemblies.

(5) The lower thermal capacity of a silicon rectifier compared to an equivalent selenium rectifier requires more coordination with protective equipment.

(6) The inverse thermal capability of silicon is much smaller than that of selenium rectifiers, hence consideration must be given to the energy level of the inverse voltage surges appearing across the silicon rectifying element.

(7) Silicon rectifiers have lower losses and can be operated at much higher temperatures than selenium rectifiers. Furthermore, the silicon rectifier's higher efficiency reduces the heat removal problem and allows cooler air for surrounding equipment.

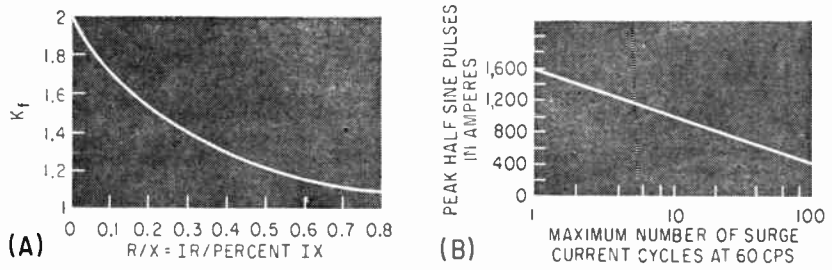
DIODE SELECTION—In selecting the current rating of high-voltage silicon rectifiers, the most important circuit parameters are the total circuit impedance (including the source) and the time-current characteristics of the protective equipment.

Unless the system has unusually high impedance, resulting in relatively low short-circuit current, diode selection will be determined by its surge current capability and will depend upon fault current and the ratio of circuit resistance to reactance.

A reasonably accurate way to find the short-circuit current during a d-c fault is

$$I_{fp} = \frac{\sqrt{2}\ I_{rms}\, K'_f \times 10^2}{\text{percent } IZ} \qquad (1)$$

where I_{fp} = peak fault current, I_{rms} = rectifier transformer rated high-voltage line current, percent IZ = system percent-impedance based on rectifier transformer Kva rating, K_f' = displacement factor for any time interval after fault occurs, and is related to circuit



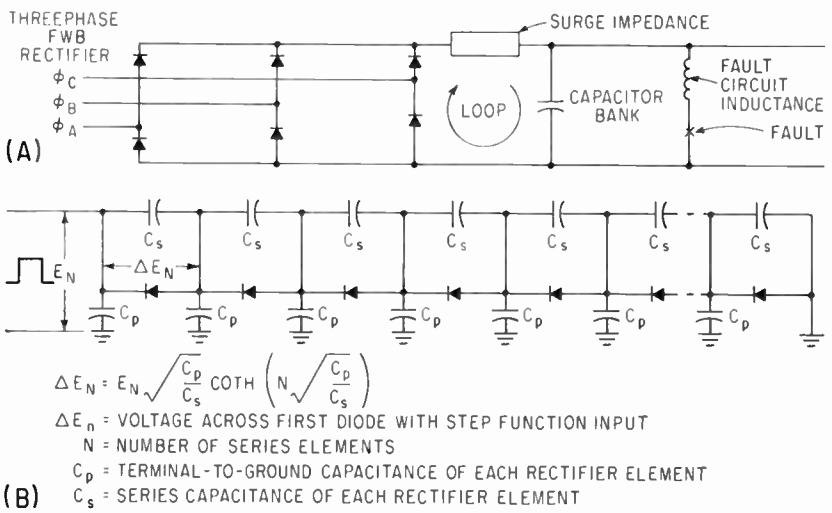
VARIATION *of displacement-factor versus circuit resistance-inductance ratio for first peak of fault current (A); typical surge-current relation for silicon diode operating in −40 C to +200 C range (B)—Fig. 1*

parameters by $K_f' = K_f \exp - (Rt/278X)$, t = time interval after fault occurs expressed in degrees, K_f = displacement factor for first current peak (See Fig. 1A), R = circuit resistance, X = circuit inductive reactance, and R/X = percent IR/percent IX.

The silicon rectifier manufacturer will supply short-time overcurrent capability curves that are generally expressed as peak half sine waves of current for a number of cycles. A typical curve is shown in Fig. 1B. The half sine waves of current are considered to be true half sine waves having only 180 degree duration out of 360. Since the peak fault current calculated by Eq. 1 is not a half sine wave but longer than 180 degrees, this must be taken into consideration in arriving at the rectifier short-circuit rating.

Besides meeting short-circuit current requirements, the selected diode must also have the required steady-state current capability based on the operating ambient, conduction period, duty cycle, and so on.

SURGE CURRENT — In systems having capacitance input filters or capacitance loads, the capacitor bank voltage may reverse in polarity after a d-c fault, if the fault-resistance is insufficient to damp out oscillations. If the reversed-voltage capacitor is connected directly across the rectifier, it can draw high currents through the rectifier since the capacitor voltage is added to the supply voltage. This current would be limited only by the impedance of the capacitor and rectifier loop. Since such surge currents will be short lived, it is possible to protect the rectifiers by a small amount of impedance, usually resistance, in series with the capacitor-rectifier loop as shown in Fig. 2A. If the oscillating frequency of this loop is known, the same protection can be achieved by using an air-core reactor in the loop, thereby reducing the amount of loss necessary to accomplish this type of protection.



OSCILLATIONS *during fault condition can build up high reverse voltages on the capacitor bank. Surge impedance limits the rectified current (A); Equivalent circuit gives the peak-inverse voltage sustained by first diode when step-function inverse voltage is applied (B)—Fig. 2*

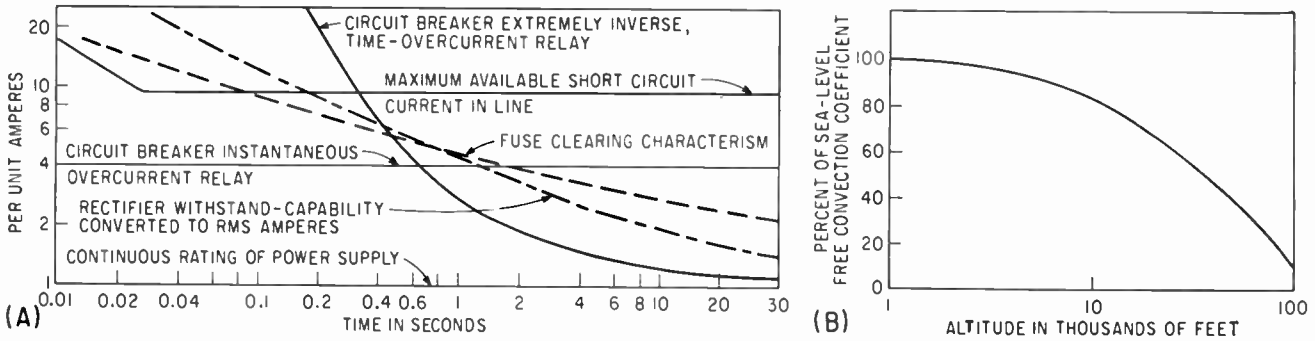
OVERCURRENT PROTECTION —Reliable operation of rectifier equipment depends heavily on overcurrent protection. Some factors governing the choice of protective elements are: relative cost of the protecting equipment, cost of equipment to be protected, and expendability of the rectifiers. The selection of protective equipment will be determined by the voltage at the protection point. For example, on some of the high-power electronic power supplies for radar systems, it is frequently impractical to use fast-interrupting, current-limiting fuses since the primary voltage of this equipment is higher than available fuses can withstand.

In the higher power ranges of equipment, the usual type of protective device is either the fast-operating air circuit breaker, alone or in combination with high voltage fuses, or devices such as high-voltage vacuum switches having a high-energy tripping circuit. For lower power equipment, current-limiting fuses used with an air circuit breaker as shown in Fig. 3A. The fuse interrupts high-level, short-time-duration current, the circuit breaker interrupts the lower levels of fault current at longer duration.[1]

In providing rapid circuit interruption, there should be protection against the effects of surge voltages that may be generated.

An advantage of current limiting fuses is that both the fuses and the silicon rectifiers can withstand practically constant energy dissipation below 1 cycle. This compatibility permits coordinating the current limiting fuse with rectifiers in the difficult-to-define area below 1 cycle, thereby eliminating the need to calculate fault current in the subcycle region. If the fuse clearing I^2t rating is less than the I^2t rating of the rectifier, taking into consideration any transformation ratio, the fuse will interrupt the fault current before the rectifier is damaged regardless of the magnitude or rate of rise in the subcycle region.

VOLTAGE DISTRIBUTION — In high-voltage silicon d-c power



CHARACTERISTICS *of fuses and circuit breakers are coordinated with rectifier characteristics to give protection during overcurrent (A); loss of air-cooling effectiveness as rectifier altitude is increased indicates that oil-immersed systems are advantageous for aircraft applications (B)—Fig. 3*

supplies it is necessary to connect a large number of individual junctions in series. Since these individual junctions have wide differences in inverse characteristics, they must be paralleled with other components to give correct division of reverse voltages in series operation. Even with rectifier cells that have matched inverse characteristics throughout the temperature range of operation, it is still good practice to parallel them with voltage-distributing elements. There are three major reasons for unequal reverse voltage distribution in series assemblies of rectifiers: (1) differences between the reverse resistance of all semiconductor devices, (2) high capacitance to ground of each junction and case, (3) unequal clearing time within the rectifier after it has been subjected to forward current. When several rectifiers are used in a series assembly, the unit with the shortest clearing time will be subjected to the full circuit inverse voltage at the instant it reverts to its blocking state. A shunt element must therefore be placed across each diode to provide a continuous path for current to flow until all diodes have recovered. Rectifier assemblies designed to withstand fast rates of change of voltage, when operated in ambients having high ground capacitance coupling, will usually have sufficient shunt capacitance to provide the shunt current around the fast-recovery diode. Hence, good voltage distribution is achieved despite recovery difference and ground capacitance effects.

The value of shunt capacitance will be determined primarily by the ground capacitance of each element and by the number of series elements in one assembly.[2] Figure 2B shows an equivalent circuit for a series assembly of rectifiers, plus the equation for calculating the voltage that would appear across the first diode in response to a step-function inverse voltage. In equipments requiring large numbers of series rectifiers, it is frequently impractical to supply enough shunt capacitance around each element to obtain adequate voltage distribution for all diodes. Then, it is more practical to use additional high-voltage capacitors in parallel with each group of rectifier and capacitor elements.

TEMPERATURE AND COOLING —Since a high voltage rectifier assembly usually includes resistors and capacitors, it must be kept cool to obtain the desired reliability. Silicon rectifiers, are mounted on heat sinks to get optimum current capability. When using aluminum to support stud-mounted silicon rectifiers, some consideration must be given to the effects of galvanic action between the aluminum and the copper stud. Furthermore the thermal reaction resulting from the unequal temperature coefficients of aluminum and copper may cause gradual loosening of the assembly, resulting in excessive thermal resistance.

In a high-voltage rectifier assembly where a considerable amount of the heat must be removed by free convection, it is important to consider the effects of reduced heat removal by free convection as altitude is increased. Figure 3B gives the variation of free convection coefficient with rectifier altitude. To get the best cooling efficiency, rectifier assemblies should be mounted with their largest dimension in the horizontal direction so that all devices in the packaged assembly will see approximately uniform temperature.

OIL VERSUS AIR COOLING — Some points to consider when deciding whether a rectifier assembly is to be immersed in a cooling liquid or in air are

(1) Adequacy of cooling by free convection and radiation.

(2) Availability of clean cooling air.

(3) Required simplicity of system.

(4) Ambient temperature, altitude, and attitude in which equipment will be operated.

(5) Availability of cooling water.

(6) Equipment complexity.

(7) Equipment reliability requirements.

(8) Allowable down time and ease of replacement.

(9) User preferences such as size, reduced noise level, corona suppression, and so on.

It is widely believed that an air insulated rectifier is easier to maintain than an oil filled one; however, this is not necessarily so. For high-voltage assemblies it is often simpler to design an easily serviced oil-filled installation than an air insulated one. And advantage of oil immersion is smaller electrical gaps, hence smaller rectifiers.

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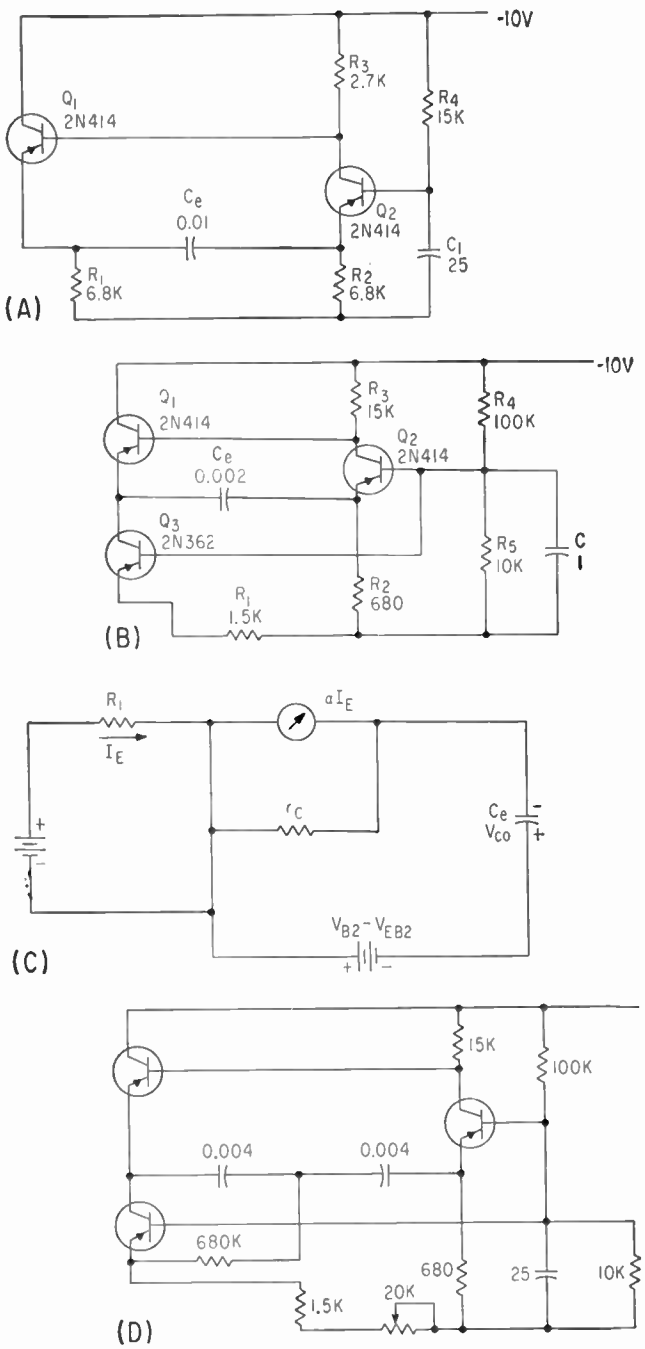
One More Transistor Makes a Linear Sawtooth



EMITTER-COUPLED *multivibrator (A) can be converted to sawtooth generator (B) with equivalent circuit shown in (C). Final version shown in (D)—Fig. 1*

Using two transistors in an emitter-coupled multivibrator and a third as a constant-current generator produces a sawtooth with linearity equivalent to that obtained with a vacuum-tube device

By BRANKO RAKOVIC
Elektrotehcnicki Fakultet, Belgrade, Yugoslavia

ANALYSIS of a Miller integrator that uses a transistor as the active element shows that highest linearity comes when the collector resistor is left out of the circuit. Then the circuit reduces to discharging a timing capacitor through a constant-current generator. But for sweep linearity, transistor sweep generators using a constant-current source compare favorably with negative-feedback integrators.

MULTIVIBRATOR—The circuit of an emitter coupled multivibrator is shown in Fig. 1A. When transistor Q_1 conducts, Q_2 is cutoff and conversely. Duration of both quasi-stable states is controlled by charging and discharging timing capacitor C_e.

Time constant C_1R_4 in the base circuit of Q_2, is much greater than the period of oscillation therefore Q_2 base voltage is constant. Transistor Q_2 should saturate when conducting otherwise a noticeable distortion in the flat tops of the rectangular output pulses will result.

During the period in which Q_2 conducts, timing capacitor C_e discharges through R_1 and Q_2. The discharge current generates a negative voltage across R_1 that keeps Q_1 cutoff. In the second quasi-stable state, the timing capacitor charges through R_2 and Q_1 while the negative voltage drop across R_2 keeps Q_2 in its off state.

Discharging current of the timing capacitor is

$$i\,(t) = [(V'_{C2} + \Delta V_{C2})/R_1]\,e^{-t/\tau} \qquad (1)$$

where V'_{C2} is collector voltage of Q_2 when this transistor is on,

$$\Delta V_{C2} = R_3\,(I_{C2} - I_{CO1} - I_{CO2} - I_{B1}) \approx R_3\,(I_{C2} - I_{B1})$$

is the height of the rectangular output pulse and τ is the time constant of the discharging circuit

$$\tau = C_c [R_1 + [R_{O2} R_2 (R_{O2} + R_2)] \approx C_c R_1 \quad (2)$$

The output resistance of Q_2; $R_{c2} \approx r_c + r_b (1 - \alpha)$ can be neglected as small compared to R_1.

The emitter voltage of nonconducting Q_1 is

$$V_{E1} (t) = R_1 i (t) = (V'_{C2} + \Delta V_{C2}) e^{-t/C_c R_1} \quad (3)$$

The discharging period of the timing capacitor will terminate when the emitter voltage of Q_1 equals V'_{C2}. Consequently, duration of quasi-stable state T_1, in which Q_2 conducts, can be determined by

$$T_1 = C_c R_1 \log [1 + (\Delta V_{C2}/V'_{C2})] \quad (4)$$

Similarly, the duration of the second quasi-stable state is

$$T_2 = C_c R_1 \log [(V'_{C2} + \Delta V_{C2})/V_{B2}] \approx C_c R_2 [1 + (\Delta V_{C2}/V'_{C2})] \quad (5)$$

Ratio of durations of quasi-stable states can be varied over a large range by changing ratio of R_1/R_2.

SAWTOOTH GENERATOR—A sawtooth generator can be derived from the multivibrator by substituting transistor Q_3 (see Fig. 1B) for emitter resistor R_1. This transistor is a constant-current generator and a good approximation of the behavior of the discharging circuit of the timing capacitor at the beginning of the sweep is shown in Fig. 1C. In the equivalent circuit, V_{B2} is the base voltage V_{EB2} is the emitter-to-base voltage of transistor Q_2 and V_{CO} is the initial voltage across the timing capacitor.

During sweep generation, the timing capacitor charges from its initial value of $-V_{CO}$ toward the Thevenin steady-state value

$$V_{ss} = \alpha I_e r_c = [(\alpha V_{B2})/R_1] r_c \quad (6)$$

To obtain maximum possible amplitude of sweep with given supply voltage, a relatively high R_3/R_2 ratio, hence a small value V_{B2} should be used.

In the circuit of Fig. 1B, V_{B2} is about 0.6 v and sweep amplitude is better than 90-percent of supply voltage. However, even though V_{B2} is small, equivalent voltage V_{ss} can be as high as several hundred volts since collector resistance r_c can be higher than 2 megohms when collector current is small.

As sweep amplitude is less than 10 v, only a small percentage of total exponential charging curve is used for sweep generation. Consequently, a highly linear sweep is obtained.

During sweep, collector voltage of Q_3 is

$$V_{C3} (t) = -(V_{CO} + V'_{C2}) + \frac{1}{C_c} \int_0^t i dt$$
$$= -(V_{CO} + V'_{C2}) + [(\alpha V_{B2})/(C_c R_1)] t \quad (7)$$

where V_{CO} is the voltage across the timing capacitor at the beginning of the sweep, V'_{C2} is the collector voltage of Q_2 when this transistor is on and V_{B2} is the base voltage of Q_2.

When the collector voltage equals V'_{C2}, Q_1 begins to conduct and a regenerative action starts bringing the circuit to a quasi-stable state in which the timing capacitor recharges quickly through R_2 and Q_1. From Eq. 7, the duration of the sweep is

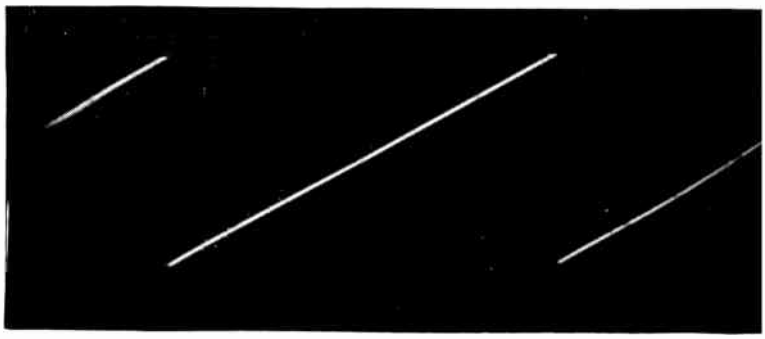
$$T = C_c R_1 (V_{CO}/\alpha V_{B2}) \quad (8)$$

The time for sweep recovery depends directly on value of R_2. Decreasing this value increases recharging current through the timing capacitor thus shortening sweep recovery. Limitation for the smallest value of R_2 is imposed by necessary condition for oscillations; that is, loop gain must be greater than unity.

For any given value of timing capacitor C_c, duration of sweep can be linearly varied by using a 20,000-ohm variable resistor in series with R_1—duration of sweep can be varied 1:10. Equation 6 shows that increasing the value of R_1 reduces equivalent voltage V_{ss}. This deteriorates sweep quality for higher values of emitter resistor near the lower end of the frequency range.

To compensate for linearity deterioration, the timing capacitor is split into two equal parts and a feedback resistor is connected between the center point and the emitter of Q_3 as shown in final version Fig. 1D. Optimum value of feedback resistor is adjusted experimentally.

Sweep linearity is shown in Fig. 2. A 670 μsec sweep is shown when R_1 equals 21,500 ohms.



OUTPUT *waveform of 670 μsec sweep with R_1 = 21,500 ohms—Fig. 2*

TRANSISTORS AND LINEARITY

Feedback integrators such as phantastron and other circuits based on Miller integrator principle are used extensively to generate sweep signals. They usually use vacuum tubes because of excellent linearity and circuit simplicity. Although many circuits have used transistors, direct duplication is not always possible. To simulate phantastron action it is necessary to use three transistors instead of one multigrid vacuum tube.

Here, the author uses two transistors in an emitter-coupled multivibrator and one transistor as a constant-current generator to produce a sweep equivalent to that produced by vacuum-tube circuits.

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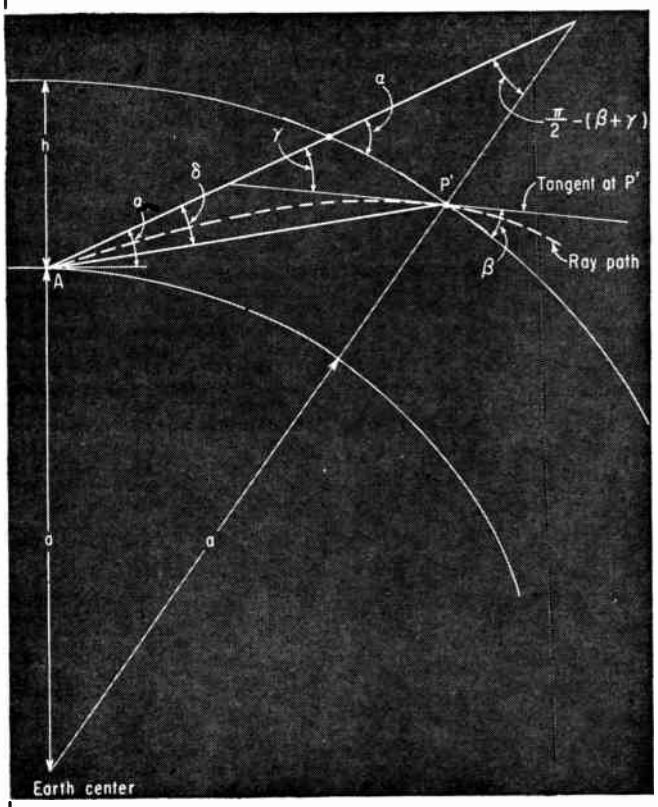
Over two-million observations were used to derive these charts. Sixty-two weather stations in the United States gathered data on surface refractivity over a period of eight years and fed it to the Central Radio Propagation Laboratory of the National Bureau of Standards. The Laboratory then worked up the new refractivity-height function given in Eq. 7 in this article.

Recent Refraction Data Corrects Radar Errors

Actual measurements of angle and range errors caused by tropospheric refraction of radar beams have been reduced to easy-to-use charts



BENDING *of a radar beam through a refractive layer and the parameters for calculating errors in angle and range—Fig. 1*

By HERBERT H. SHANNON
Space Systems Division, Martin Company, Baltimore, Maryland

ACCURACY of radar tracking of celestial bodies, satellites, missiles and other high-altitude objects depends upon the amount of bending of the radio waves as they pass through the earth's atmosphere. A negative-exponential model of the refractivity-height function for the United States was used to calculate the angular and retardation (or range) errors due to tropospheric refraction.

Radio waves propagated through a medium whose index of refraction is a varying function of the path undergo refractive bending and a retardation in velocity of propagation. Since the atmosphere is a varying medium, a radio wave propagating through it will experience bending as in Fig. 1. The radar is situated at point *A* on the surface of the earth, and is elevated at an initial elevation angle a_o above the horizontal. The apparent ray path to the target is the straight line from A to the upper right corner. However, due to refractive bending, the actual ray

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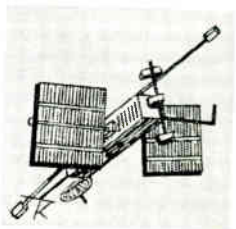

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path is the broken curve AP' and the angle δ is the inherent angular error due to refraction.

Angular error (δ) may be found from the geometry of Fig. 1 and Snell's law of refraction for spherical boundary surfaces. Applying Snell's law to Fig. 1

$$\eta_0 a \cos \alpha_0 = \eta \rho \cos \beta \tag{1}$$

and

$$a \cos (\alpha_0 - \delta) = \rho \cos (\beta + \Delta\gamma - \delta) \tag{2}$$

where η_0 = index of refraction at the surface of the earth, η = index of refraction at the altitude h, a = mean radius of the earth (20.9027×10^6 ft), and $\rho = a + h$.

By trignometric identities, the small angle approximations for δ and γ, and Eq. 1, the elevation angle error may be obtained from Eq. 2 in the form

$$\delta = \frac{\gamma \tan \beta - (N_0 - N) \times 10^{-6} + \gamma^2/2}{\gamma + \tan \beta - \tan \alpha_0} \tag{3}$$

where $N = (\eta - 1) \times 10^6$ = modulus of refractivity and γ = total bending through the troposphere.

Let the troposphere be divided into m incremental layers so that the index of refraction in any layer can be considered linear. The total bending through the incremental tropospheric layers is

$$\gamma = \sum_{j=0}^{m} \frac{(N_{j-1} - N_j)}{500 (\tan \beta_{j-1} + \tan \beta_j)} mr \tag{4}$$

Range error ΔR through an incremental atmospheric layer Δh is

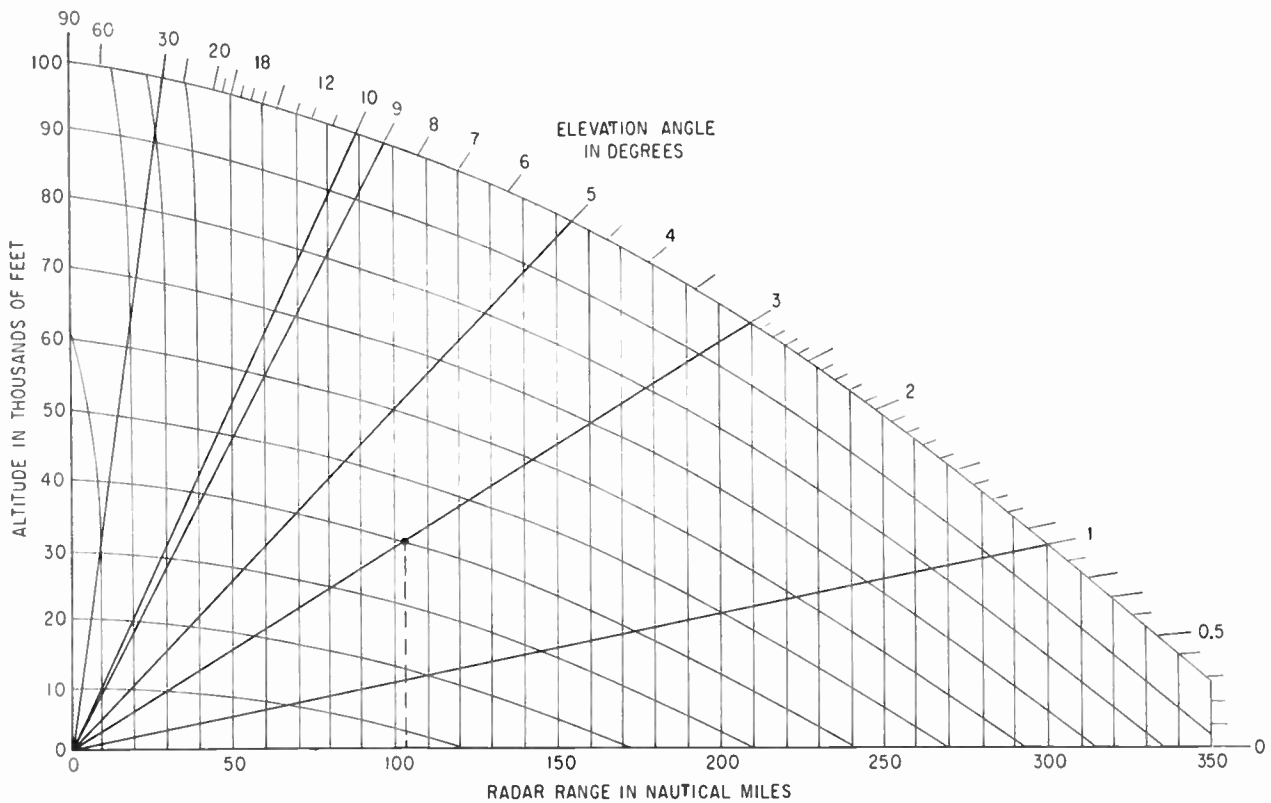
$$\Delta R = \int c \, d\tau \tag{5}$$

where c = velocity of propagation in free space and $d\tau$ = signal retardation through the incremental layer. Evaluation of the integral yields

$$\Delta R = \sum_{j=0}^{m} \frac{(N_{j-1} + N_j)(\Delta h_j) 10^{-}}{\sin \beta_{j-1} + \sin \beta_j} \tag{6}$$

Thus, it is possible to calculate the inherent angular and range errors due to atmospheric refraction if the index of refraction is known.[1]

General practice has been to assume an atmospheric refractive index that decreases linearly with the height above the surface of the earth. The 4/3-earth-radius principle, based upon this linear assumption, is described in texts on radio engineering. However, the linear assumption leads to serious errors at long ranges and low elevation angles. To avoid these errors, a negative-exponential model of the refractivity-height function was proposed. One of



RADAR RANGE-*height-angle chart. Any one parameter may be found when the other two are known—Fig. 2*

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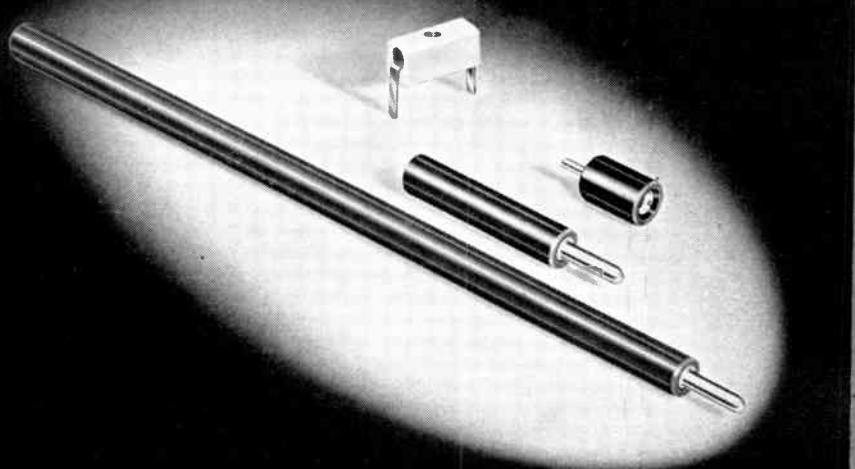

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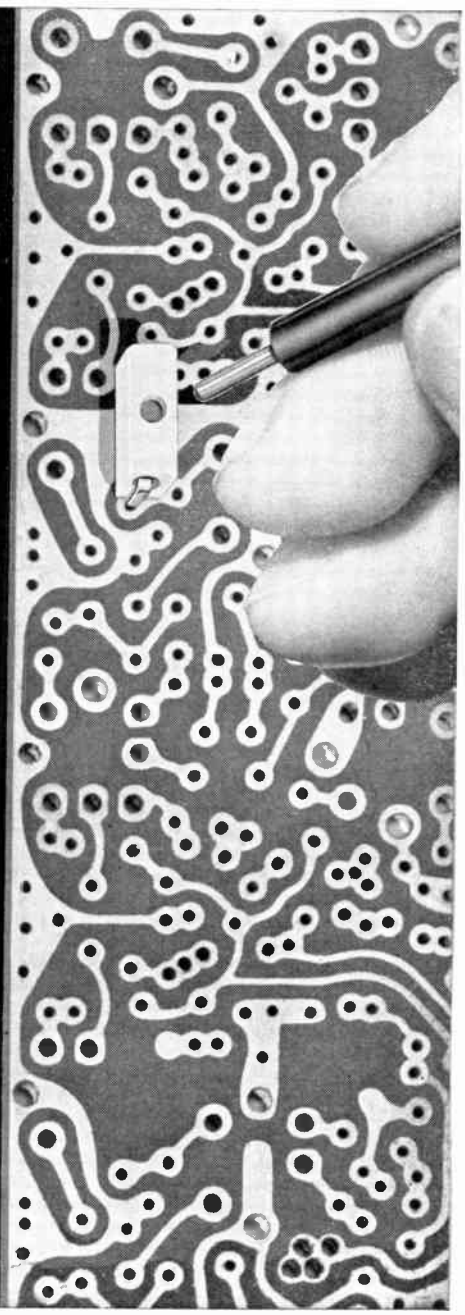

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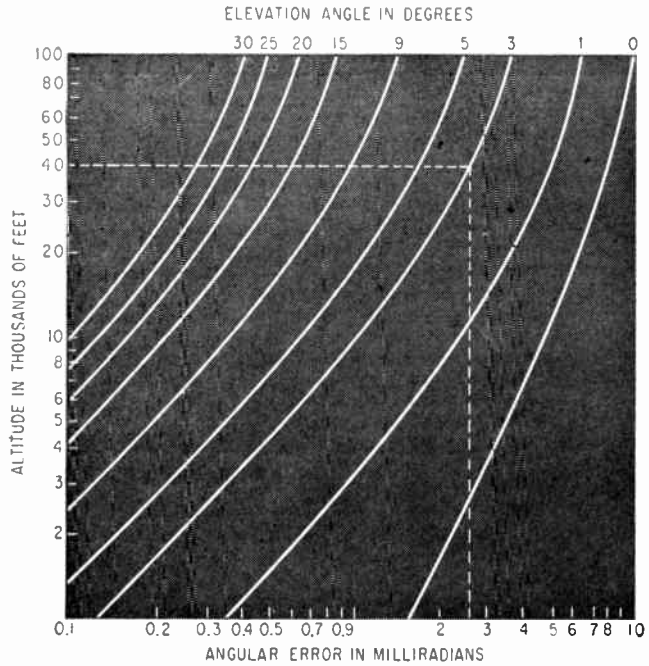
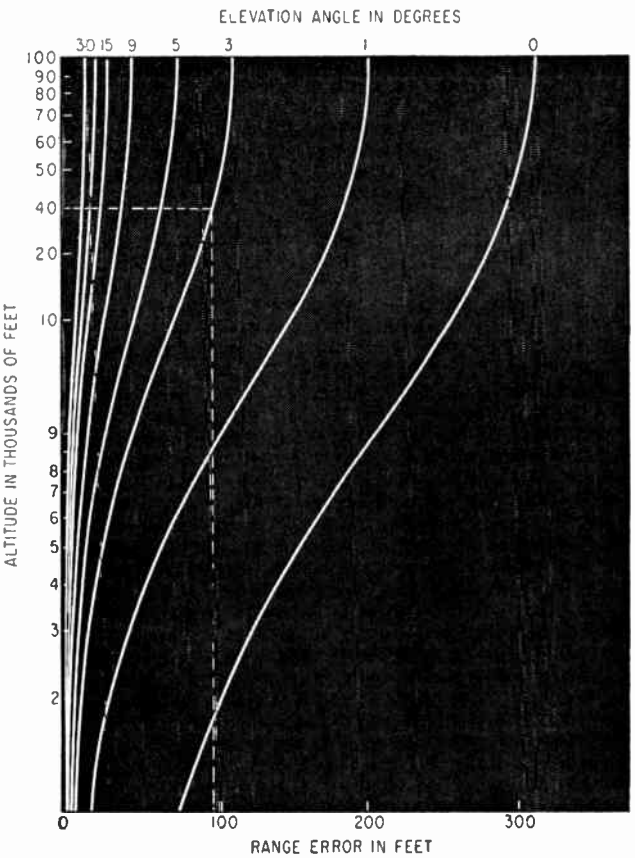


ANGULAR ERROR *given when elevation angle and altitude are known—Fig. 3*



RANGE ERROR *given when elevation angle and altitude are known—Fig. 4*

the models proposed is

$$\eta\,(h) = 1 + 0.000313 \exp\,(-0.04385h), \qquad (7)$$

where h is in thousands of feet. This model is based upon a surface index of refractivity obtained by averaging about two million observations and is referred to as the CRPL (National Bureau of Standards Central Radio Propagation Laboratory) Exponential Reference Atmosphere.

The CRPL Reference Atmosphere was used in Eq. 3 and 6 to calculate the tropospheric angular and range errors presented graphically in Fig. 3 and 4 respectively. The CRPL Reference Atmosphere was also utilized to derive the radar range-height-angle chart, Fig. 2.[2, 3] This chart can be used to find the third parameter when the other two are given. The three graphs are valid when one terminal of the propagation path is not more than a few hundred feet above the surface of the earth, and when the transmitted frequency is in the range of 500 to 50,000 Mc where the index of refraction is not a function of frequency. The angular error is the same for either a one way or round trip passage through the atmosphere. However, the range error is a function of the total path length, and therefore the range errors obtained from Eq. 4 must be doubled for a round trip passage through the atmosphere.

EXAMPLE—Indicated range and elevation angle to radar target is 103 nautical miles and 3 degrees respectively. What are the angular and range errors due to atmospheric refraction? Target altitude for the given range and elevation angle obtained from Fig. 2 is 40,000 feet. The errors obtained, using Figs. 3 and 4, for an angle of 3 degrees and an altitude of 40,000 feet are 2.67 milliradians and 97.5 feet.

The author thanks J. Pettus of the Space Systems Division, Martin-Marietta Corp., who wrote the computer program for calculating the atmosperic errors.

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(3) B. R. Bean and G. D. Thayer, "Models of the Atmospheric Radio Refractive Index," *Proc. IRE*, 47, pp 740-755, May 1959 and 58, pp 1498-1501, August 1960.

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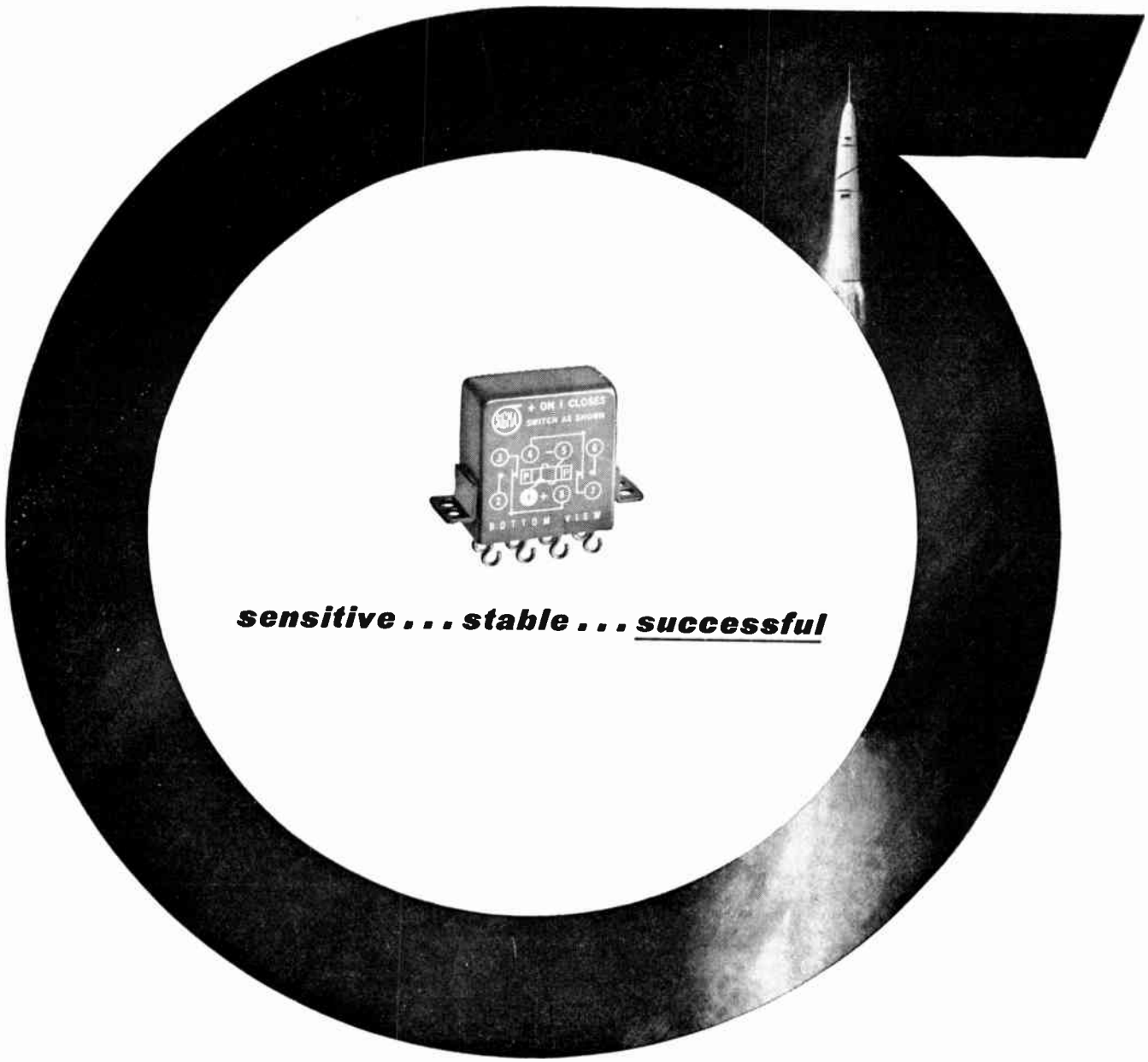

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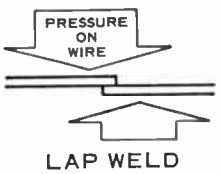
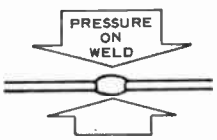


LAP WELD

With a lap weld, however, the number of bends obtained before the lead breaks, is dependent on the strength of the tantalum or nickel wire. The wire breaks before the weld.



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LAP WELD AVOIDS EMBRITTLEMENT

With a lap weld, the very small area of overlap (1/16" to 3/32") creates a high resistance path for the welding current. A small volume of each lead quickly melts and the electrodes' pressure holds them in intimate contact until the newly formed nickel-tantalum alloy cools. The weld is completed so quickly, little or no gas can be absorbed by the tantalum to cause embrittlement of the lead.

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Hollow Cathode Enhances Plasma Electron Gun

System shows promise for new amplifiers, oscillators and control circuits

By L. H. STAUFFER
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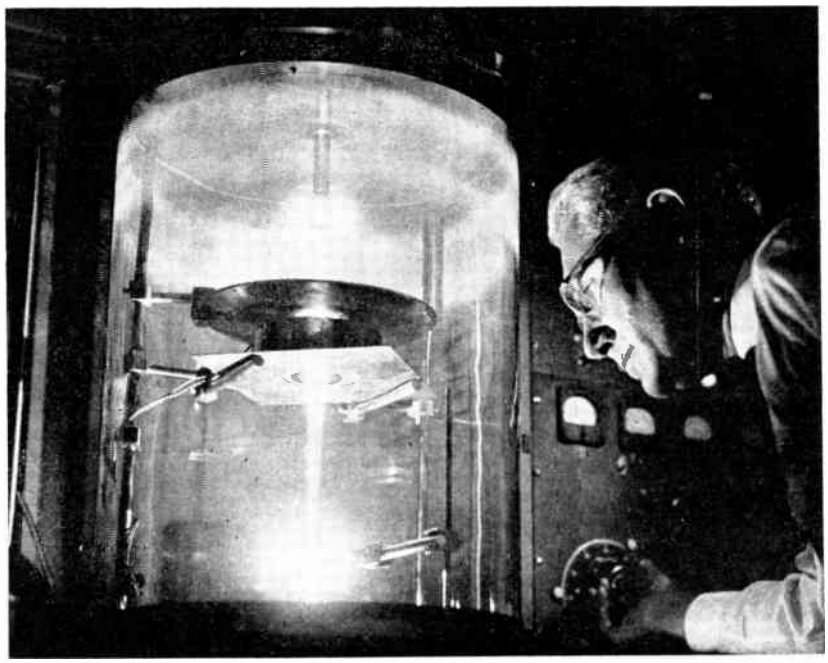


ELECTRON BEAM *emerges as narrow collimated beam out of cathode, top, is focussed to a point by magnetic coil, to achieve maximum energy concentration on target at bottom of bell jar*

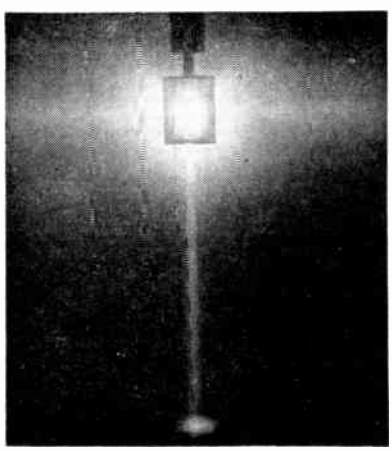
ENERGY CONCENTRATIONS of approximately 600,000 watts per square inch have been realized with a plasma-focusing electron gun system using an input voltage of 5 to 20 Kv. Developed by GE's General Engineering Laboratory, the system uses a perforated hollow cathode and a grid element (inside the cathode) to produce an electron beam current of 2 amperes.

The system has been operated at the above low voltage range (as against 100 Kv for conventional electron guns) to produce a 30-inch electron beam that can be focused to a diameter of 0.01 inch or less.

Using a plasma gas environment, the system activates the "gas-focusing" effect which is enhanced by the cathode-grid combination. This effect overcomes a basic problem of conventional (thermionic emission) electron guns, where mutual repulsion of electrons tends to limit the electron beam current density that can be obtained in a high-vacuum environment.

Obvious applications include electron beam welding, melting and refining of refractory materials, and chemical processing. Possibilities include use in new types of amplifiers, oscillators, and control circuits. Also being explored are microwave generation by plasma interactions, light source excitation, ionization of gases.

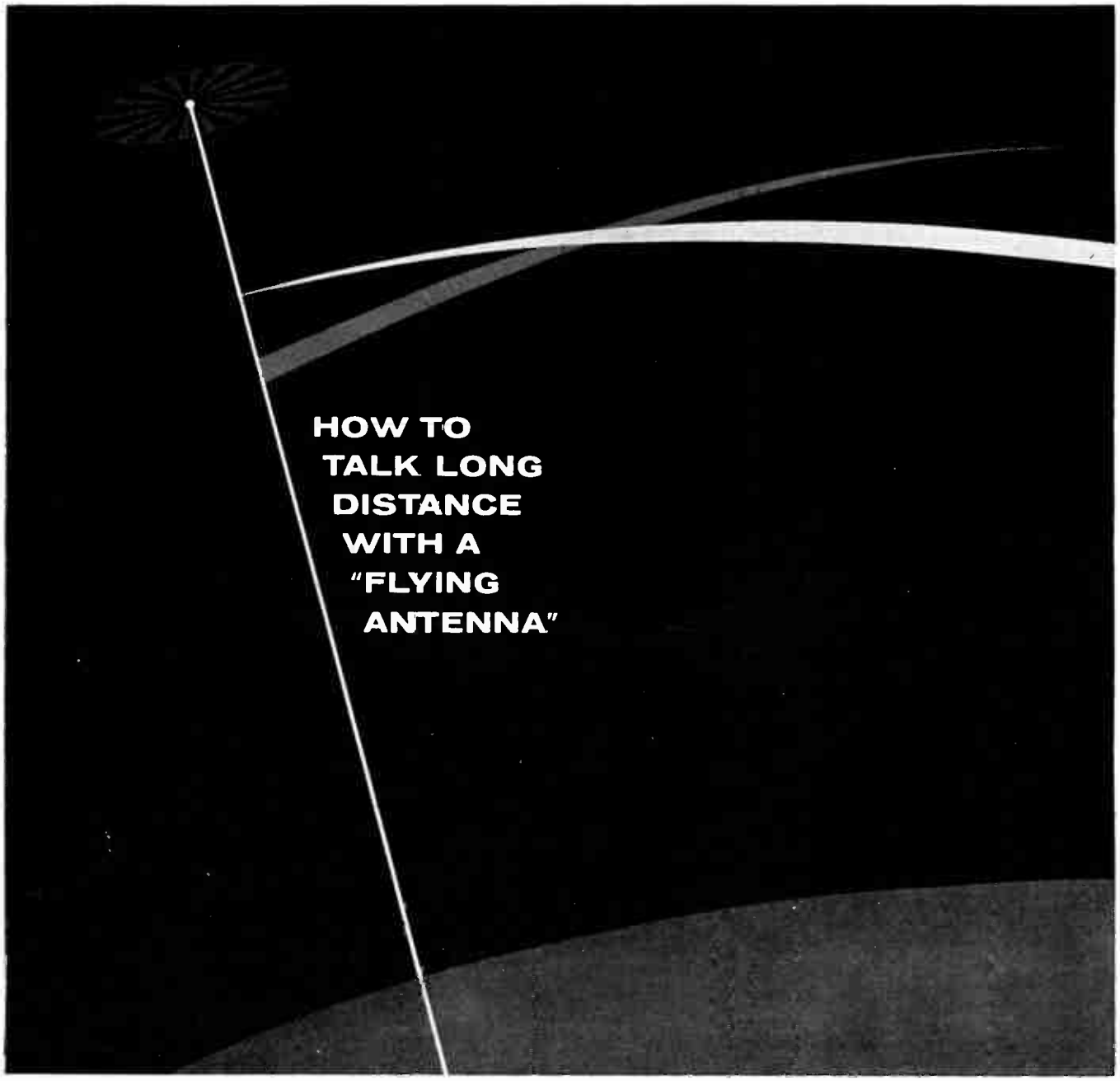
OPERATING PRINCIPLE — The plasma gas environment is created when an inert gas (such as helium and argon) is subjected to a suitable voltage gradient generated by the perforated hollow cathode. High-velocity positive ions from the plasma sheath enter the cathode through the perforations and the beam's exit aperture. Ion bombardment of outside and inside surfaces of the cathode produces secondary electron emission. Electrons inside the cathode are concentrated into a beam by electrostatic fields penetrating through the beam's exit aperture and acting on the internal plasma. Electrons outside the cathode accelerate away from the cathode to collide with gas molecules and thus form a continuous supply of positive ions. Some of the electrons outside the cathode strike the walls of the system's glass container, rather than hitting gas molecules, to cause fluorescence and heating of the walls.



SELF-COLLIMATED *electron beam from a perforated hollow cathode in helium—Fig. 1*

To further improve control of the self-focusing beam, an insulated grid is located inside the cathode. Made of mesh molybdenum wire and formed to an open-ended cylinder, the grid does not initiate or extinguish the glow dischcarge, but controls electron flow. Response time of the electron gun is limited only by inter-electrode capacitance and electron transit time.

LOW TEMPERATURE — The cathode's secondary emission of



For special-purpose, long-range communications, Fairchild Stratos-ESD has created and developed Helevator. An electric-powered rotary wing tethered drone, it can hover as high as 9,000 feet, stay aloft 1,000 hours without maintenance. The tether itself serves as the antenna for VLF and LF transmissions. Helevator* can act as a sensor platform for difficult short-range surveillance and a relay for UHF/VHF communication. The "Flying Antenna" is a compact, mobile, economical system; ready for immediate deployment and equally fast concealment. Operating from land or sea, it can withstand the foulest weather. Interested? Let our Helevator brochure tell you more. Contact our Director of Customer Relations.

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electrons enables the cathode to operate at temperatures too low for appreciable thermionic emission of electrons. While the plasma inside the cathode may supply some electrons, most of the beam's current is made up of electrons from the cathode's inner surface. Proof of this is the suppression of beam current by a negative grid bias of 8 volts that repels electrons from the cathode. Secondary emission is facilitated by such cathode materials as molybdenum which allow a single energetic ion to remove one or more electrons.

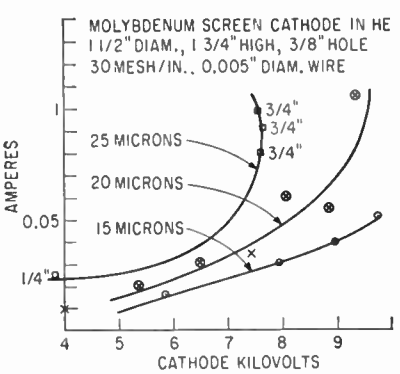
GENERAL DESIGN—Figure 1, seen on page 60, shows a cathode made of 40-mesh 10-mil stainless steel screening emitting a self-collimating electron beam in helium at approximately 15 microns pressure. This cylindrical cathode measures 1⅛ inch × 1½ inch and has a ¼-inch beam exit aperture. A stainless-steel stem extending through an insulating bushing supports the cathode from an aluminum cover plate which acts as the anode. This cover plate together with a large glass cylinder form a bell jar; selected gases can be admitted at pressures in the micron range. The characteristic is shown in Fig. 2. The electron beam path is marked by the luminosity of excited atoms in its path. Ordinarily the gas density is too low to cause appreciable scattering of the beam. Beams up to 30 in. in length have been produced with little spreading. Typically the beam cross section is about the size of the exit aperture, though it can be made smaller by adjustment of pressure and cathode voltage.

At pressures and voltages outside the range of the beam mode, a more or less diffuse glow discharge is obtained. In argon the beam mode is most easily supported at pressures from 3 to 10 microns with applied cathode voltages from 5 to 10 Kv, depending on gas pressure and cathode characteristics. In lighter gases, such as hydrogen and helium, the beam mode is obtained at higher pressures (10 to 100 microns). Beam currents range up to 2 amperes for a 3-inch cathode in argon with 20 Kv applied. Divergent or convergent beams may be obtained by slight changes in gas pressure or cathode voltage.

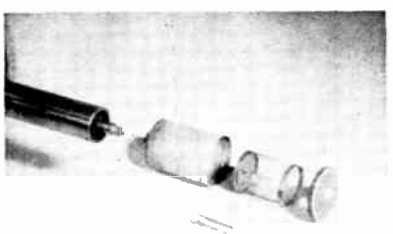
Measurements of beam power delivered to a shielded cup have shown that from 75 to 95 percent of the input power resides in the electron beam.

GRID CONTROL—The open-ended cylinder grid made of 0.005-in., 32-mesh molybdenum wire measures ⅜-in. in diameter and 1⅛-in. long. This is supported inside the stainless steel cathode with a transmission factor of about 30 percent and an internal diameter of about 1⅛ inch. Figure 3 shows an exploded view of the assembly.

If allowed to float, the grid always assumes a positive potential (several hundred volts) with respect to the cathode. When a variable d-c bias is applied from an isolated potentiometer, the beam current can be varied over a wide range without affecting beam focus. Even though substantial grid current is drawn, the grid power is only a few tenths of a watt because of the low grid potentials employed for beam control.



CURRENT-VOLTAGE *characteristics for the beam mode at various pressures in helium—Fig. 2*



GRID-CONTROLLED CATHODE *assembly, exploded view—Fig. 3*

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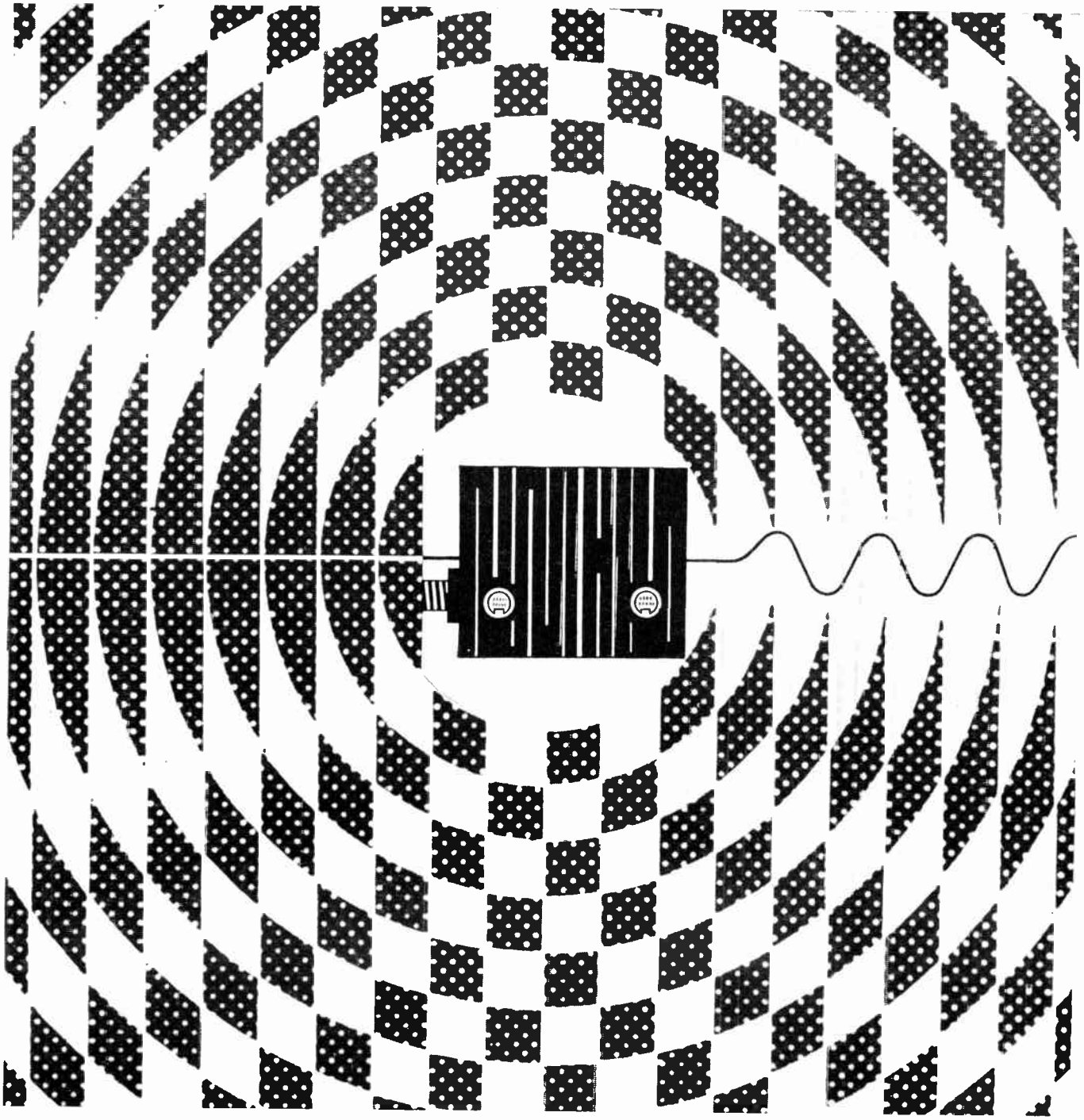

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This new Delco 250 VA power supply converts 28 volts DC to 115 volts, 400 cps. Its circuits are a model of simplicity.

The unit is designed for continuous full-load operation at 71 degrees C. still air, yet weighs only 10 lbs., measures 6¼" x 7⅜" x 5". A minimum of components assures extra-high reliability.

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Production of Collimated Electron Beams, Bull Am Phys Soc, 7, p 69, Jan. 1962.
(2) H. L. L. Van Paassen, E. C. Muly and R. J. Allen, Electron Beam Phenomena Associated With Perforated Wall Hollow Cathode Discharges, Proc National Electronics Conf. 17, p 590, 1962.

Munich Gets Switchboard With Magnetic Coupling

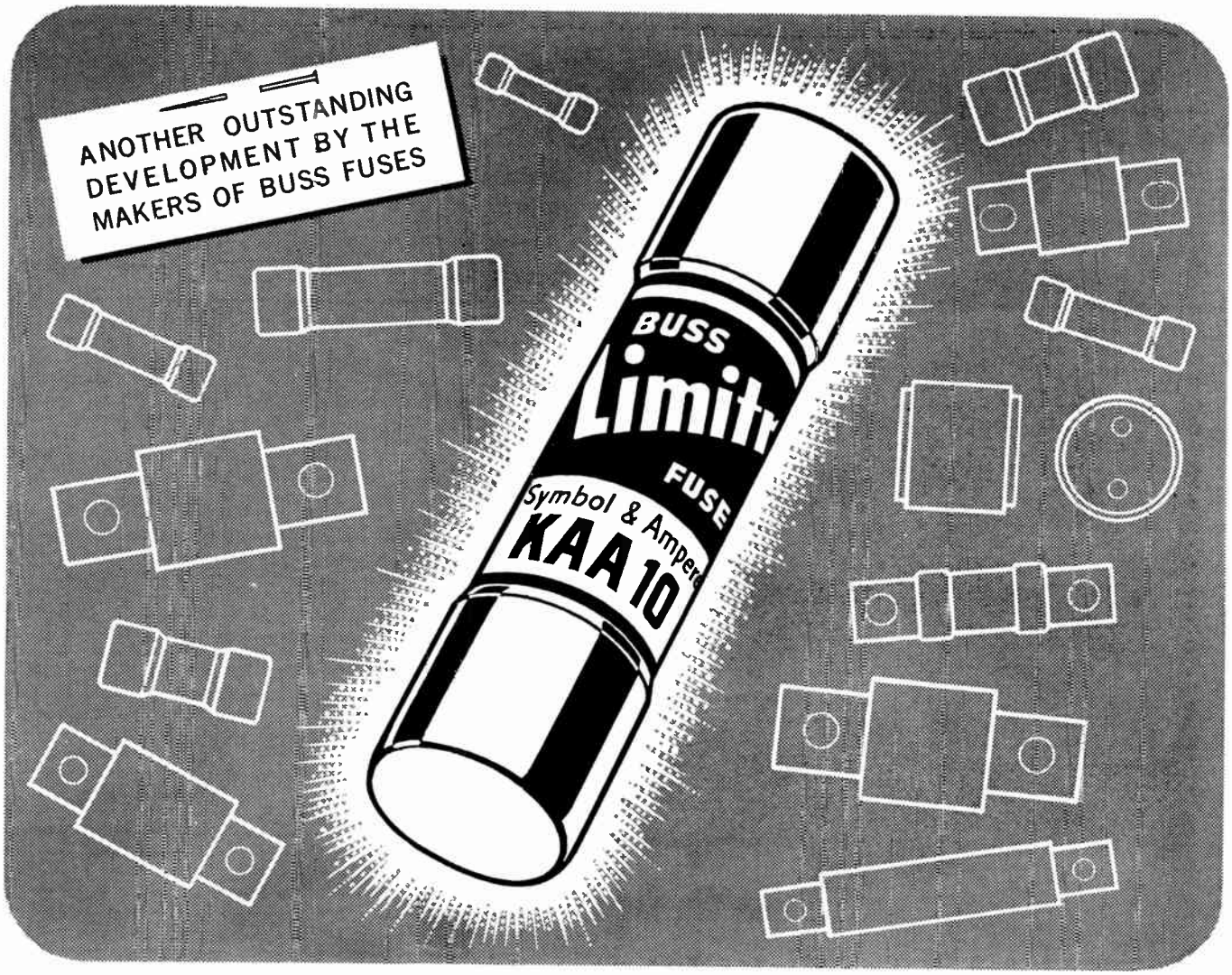
BONN—Siemens' ESM technique (elektronisch gesteuertes System mit Magnetfeldkopplern, or electronically controlled system with magnetic field coupling) for high-speed telephone circuit switching recently went into commercial operation in Munich. It is a dial exchange employing protective gas contacts for all switching operations. The first group of 500 telephones are already connected.

The electronic marker that controls all identification and switching operations for the dialed-in numbers has been designed to serve 10,000 separate telephones. Present planning calls for three such markers in each exchange. Each would, with its 40-msec switching time, permit three local calls per telephone each hour.

Gas-filled dry-reed switches perform the operations required by the computer-created logic complex in forming a speaking circuit. Instead of employing impulses from dialed-in numbers to select the path to the desired digits, the ESM technique stores the impulses and transforms them into a multi-frequency code which more readily triggers the switching circuit. Selection of the logic complex is said to be accomplished in the time-span between any two individual dialed-in numbers.

The West German Post Office is considering, in view of the more rapid circuit selection speed made possible by the ESM technique, a changeover from conventional dial telephones to push-button types using keyboards similar to standard desk calculators.

Ease of maintenance has been achieved by building a separate checking section into each marker. Should a malfunction occur, the checking unit sounds an alarm, initiates countermeasures and automatically transfers the call being made to the other two markers in the exchange building. Then the malfunctioned markers checker



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punches out a tape describing the trouble and the counter-measures that it has initiated.

A secondary checker in each marker measures all 1.5 million contacts of a 10,000-telephone exchange during the low-traffic night hours. Contacts in need of service or change are identified out on a punched tape.

Thermionic Converters Produce Over 20 Watts

THERMIONIC CONVERTERS that can produce appreciable electric power directly from the sun's heat were developed in experiments conducted for the Air Force Systems Command's Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

The devices operate by heating solid material to the point where electrons boil off, cross a vacuum and are collected on a cool surface. In a closed circuit this establishes an electric current.

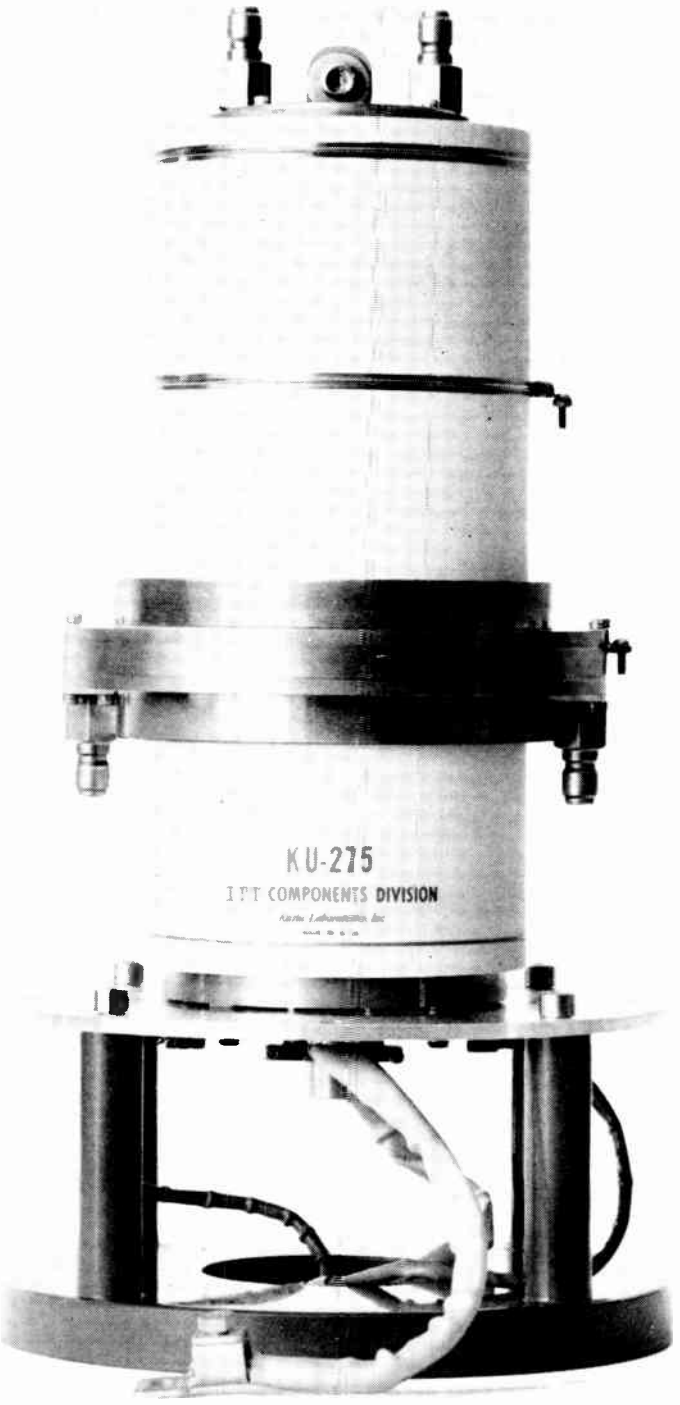
Unlike solar cells, currently used in space vehicles, thermionic converters produce electricity directly from heat; solar cells depend on the photovoltaic effect. Thermionic converters are impervious to radiation damage. Theoretically, they can be made cheaper and lighter than solar cell generators, with equal or better efficiency.

Two companies are attacking the problem from different angles. Thompson - Ramo - Wooldridge, Inc. in Los Angeles obtained 20 watts at 2,600 F, using five series-connected cesium vapor converters inserted into five sides of a supporting block. The sixth side was open for the introduction of heat. Used with an electron-bombardment heater in the laboratory, the device generated 122 watts at 3,140 F.

A second thermionic generator, made by General Electric at Phoenix, Arizona, uses three cesium vapor converters in series to obtain 21 watts at 2,732 F.

Problems in fabricating thermionic converters are caused by their high operating temperatures (up to 3,200 deg F); materials and vacuum seals must withstand the heat, and the electron collectors must be kept cool. Ionized cesium vapor in the interelectrode space is used to prevent a negative-charge barrier from building up.

The A and Ω of Thyratrons



Here you see the extremes of the ITT Kuthe Ceramic Thyratrons—the smallest and the new super power KU-275. There are eight other ceramic thyratrons in addition to ceramic diodes and numerous glass thyratrons and diodes. In all, this is the most complete line of hydrogen-filled tubes, all available immediately from production.

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Forward Anode Voltage, Kilovolts	8.0	12.0	20.0	25.0	33.0	50.0	50.0
Peak Anode Current, Amperes	100	200	350	1000	2000	2000	4000
Average Anode Current, Amperes	0.100	0.200	0.300	1.5	4.0	4.0	8.0
Seated Height, Inches	1.5	1.8	2.3	5.2	10.0	12.0	16.0
Diameter, Inches	1.0	1.4	1.8	3.0	4.5	4.5	8.5

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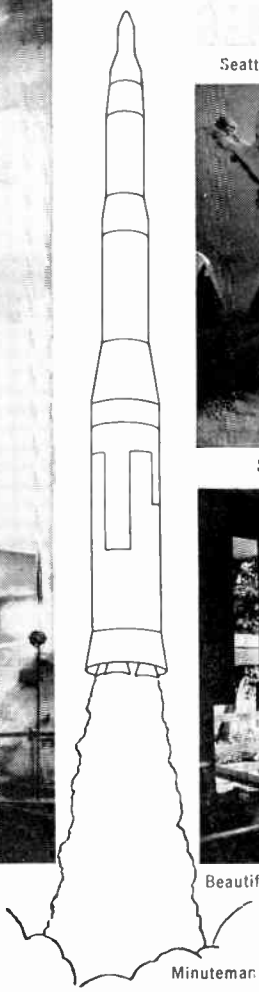

Minuteman ICBM

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We are silent about the "M" in Mnemotron but not about our new 700 Series Data Recorder. With good reason. For one, it brings the size and cost of data recording systems down to sensible proportions if your data is analog voltage from DC to 5000 cycles per second. And its features would not embarrass even the costliest instrumentation recorder. Here are a few:

COMPACTNESS. A complete 7 channel record/reproduce system uses less than two feet of rack space. A 14 channel system adds less than seven inches more.

ACCURACY. Input-output characteristic is linear within 0.2 per cent with Mnemotron unique Pulse Frequency Modulation (PFM) data conversion technique.

FLEXIBILITY. As many data channels as you need with a choice of channel format. For greatest operating economy, choose up to 7 channels on ¼ inch magnetic tape, 14 channels on ½ inch tape, standard IRIG spacing and track width of 7 channels on ½ inch tape.

INTEGRATED RECORD/REPRODUCE MODULES. A single solid-state PFM Data Converter has all the record/reproduce electronics for each channel. Simple rotary switching lets you select data conversion for 3 tape speeds. No additional plug-ins needed.

ISOLATED INPUT CIRCUITS. Input terminals of each channel are isolated from all the others to readily accept data from floating, unbalanced or differential sources.

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PRICE. 7 Channel System from $6,495

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* To answer the many inquiries, Mnemotron comes from Mnemosyne, Greek Goddess of Memory.

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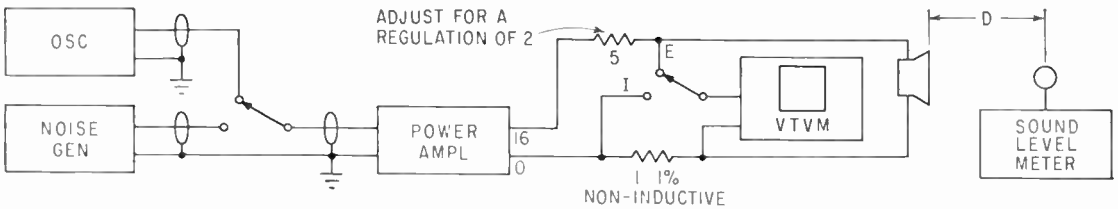
Subsidiary of Technical Measurement Corporation, North Haven, Conn.



SIMPLE *tests for rating loudspeakers can be completed using hook up shown—Fig. 1*

Loudspeaker Experts Appraise Trends

Group notes demands, proposes methods to rate audio quality

DEMAND for loudspeakers is changing, according to trends noted by Loudspeaker Section of Electronic Industries Association. Projections are based on types of loudspeakers used by set manufacturers from 1960 to 1962.

Loudspeaker analysts admit that while trends that show up during such a short interval may not be a precise indication of what can happen, the following judgments can be made:

Loudspeaker sizes under 8 inches show a healthy growth. The rise indicates that these sizes will probably account for 65 to 70 percent of all speakers used by 1967. Loudspeakers 8 inches and over may account for approximately 9 percent of all loudspeaker sizes used in the industry by 1967. Oval loudspeakers may account for about 22 percent of all speakers used five years from now.

Survey also estimates that there will be virtually no demand for tweeters by 1967. (A tweeter is generally limited to higher frequencies, 2 Kc and above).

QUALITY—In addition to reports on the trend to smaller, cheaper units, two new methods of measuring loudspeaker quality were proposed at the recent loudspeaker industry conference, held in Chicago.

The Walsh loudspeaker rating system (ELECTRONICS, p 30, July 6), proposed to help rebuild earnings and to battle foreign competition, has uncovered weaknesses in the industry, according to Hawley Products' H. W. Bingham. (The Walsh rating and color coding system would indicate frequency range, power capacity, and give loudspeakers a general-performance number.)

No uniform standards exist to measure sound quality, he said. Standard test procedures are lacking, and test equipment and facilities are generally inadequate in many companies. Pressure to reduce sizes and weight, and to cut cost, is usually done at the expense of sound quality, Bingham pointed out. Since there is no accepted way to compare or judge the sound quality of a loudspeaker, no one can effectively question the sound delivered for any particular price.

Clevite's Richard Liebich suggested that Walsh color symbols be restricted to indicating loudness sensitivity, maximum loudness and possibly power-handling capabilities. Each sound specification which can be physically measured should have a unique symbol, he said. Percentage ratings for tonal range and balance may be derived from frequency response curves, he explained. Sound dispersion ratings would express directional patterns of angular coverage. Tonal clarity percentages could be worked out from transient distortion measurements and tonal quality from special measurements of tonal intermodulation and modulation distortion.

Rating equipment proposed by Liebich included a common test baffle to be used for several measurements. This would consist of a long labyrinth of nonreflective folded ducts of constant cross section, formed by alternating air and fibre-glass perpendicular cavities around its perimeter.

SIMPLE TESTS—A simpler set of loudspeaker tests was proposed by Adelore Petrie, GE Audio Products, Decatur, Ill., using equipment already in the hands of most speaker and set manufacturers. Petrie hooked up the circuit shown in Fig. 1, showed how to complete a series of specification tests—each requiring but a few minutes.

These tests would enable loudspeakers specification labels to report type of unity, size, rating impedance, maximum input, efficiency and test voltage, he suggested.

Well-equipped independent labs would still be required to measure sound quality, smoothness of response, transient response or tone quality, with any degree of correlation.

The Hammond Organ Company has been number-rating sound quality ever since introducing its first electronic unit in 1936, Bruno Steffen, senior engineer, reported.

Intensity calibrated drawbars blend sound qualities, or voices, by mixing tones from different parts of a tone generator. Several books list the various coded settings re-

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Announces

CLEAR LAKE CITY

A major research park, industrial park and totally-planned community --next to NASA/Houston

Your company belongs next to NASA/Houston — at Clear Lake City. This 15,000-acre planned community flanks the Manned Spacecraft Center on three sides. Campus-like research and industrial areas will adjoin the MSC.

NASA/Houston recently announced acceleration of its $150 million construction program. By late 1963, operations will start concentrating at the Manned Spacecraft Center and at nearby Ellington AFB. Clear Lake City bridges these two NASA nerve centers.

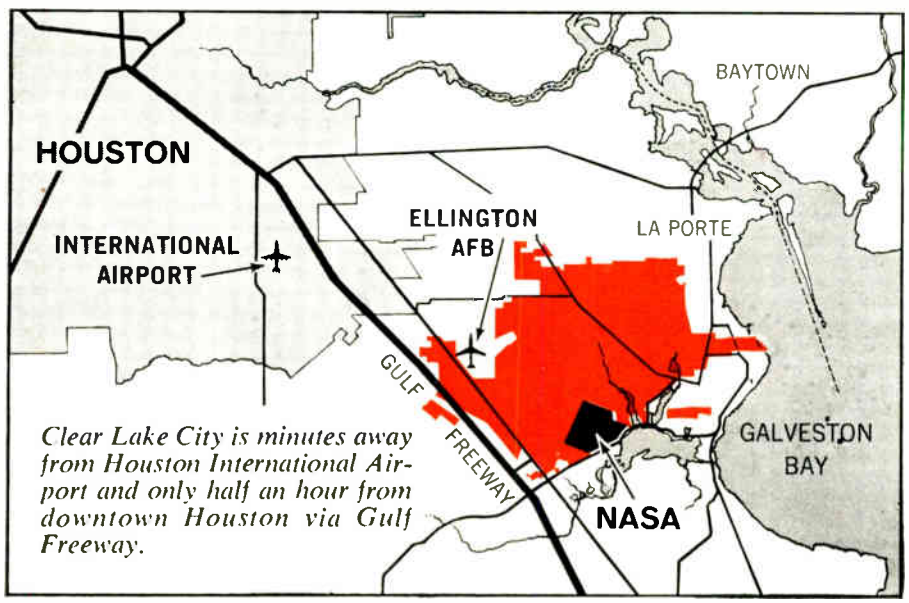
Clear Lake City Research Park occupies 1000 choice acres on NASA's northwest limits. The strategic location and meticulous planning of this park make it one of the most desirable R&D locations in the country. The Research Park will have extensive landscaping and underground utilities. Architectural controls will help achieve harmony without regimentation.

The Industrial Park, with identical improvements and controls, will adjoin the Research Park on the south. An Industrial District will be located in the northwest.

First class office space suited to technical representatives will be ready for occupancy next spring.

Clear Lake City will boast a fine motor hotel, apartment buildings, mobile home park, community center, shopping center, model homes and country club. The first nine holes of an 18-hole, four-season golf course will be playable in 1963.

Northeast of Clear Lake City, 7000 acres are to be developed for heavy industry by Humble Oil & Refining Company.



Clear Lake City is minutes away from Houston International Airport and only half an hour from downtown Houston via Gulf Freeway.

For detailed information, write or call W. Lawrence Prehn, Jr., Resident Manager, Commercial and Industrial Development, Del E. Webb Corporation, 900 Texas National Bank Building, Houston 2, Texas. Telephone CApitol 8-0781. Your inquiry will be treated in the strictest confidence.

Clear Lake City is a project of Del E. Webb Corporation for Friendswood Development Company.

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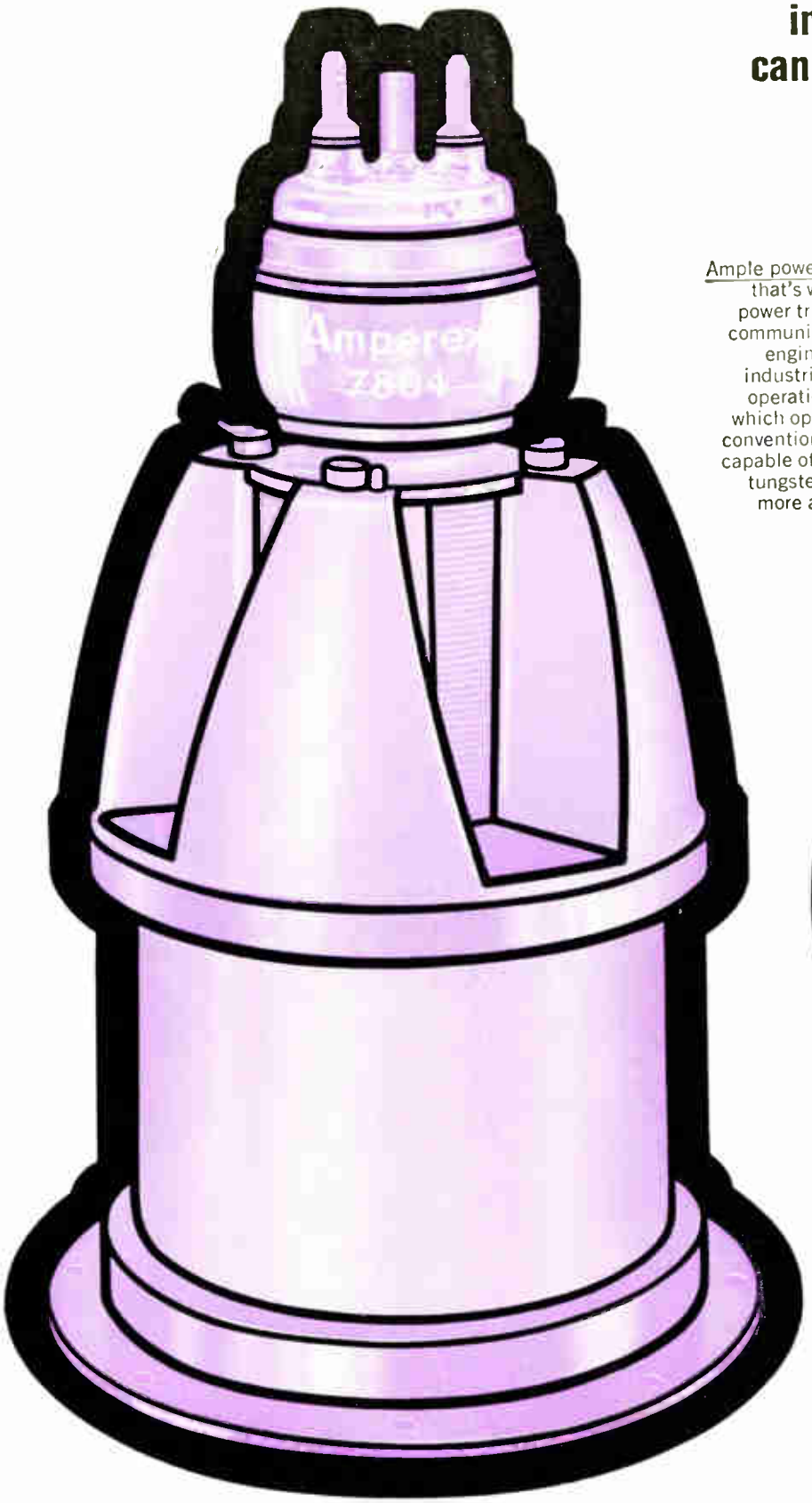
PHOENIX LOS ANGELES HOUSTON

Amperex industrial tubes, designed for industrial applications, can take an awful beating...

and a tube has to in dielectric and induction RF heating operations

Ample power output under relatively uncontrolled conditions that's what RF heating demands of power tubes. But power triodes often fail because they were intended for communications use under the close control of broadcast engineers. . . . The Amperex solution is a family of industrial triodes specifically designed for RF heating operations. These tubes employ the unique "K" grid—which operates at temperatures that would easily destroy conventional structures. They are built with massive anodes capable of heavy intermittent overload, and husky thoriated tungsten filaments with reserve emission. . . . To learn more about this "Constant Power" family, check the descriptions on the opposite page.



quired for any of thousands of unique voice qualities.

Hammond specifies magnetic motor sizes and designs to its vendors. Company also stipulates nominal sizes of loudspeakers, their efficiency levels, voice coil impedances and clearances, free air resonance, power handling, transient distortion and shape and smoothness of their response curves. Rating of Hammond-accepted loudspeakers in tests against the Walsh proposals indicated close correlation of specifications.

SOUND EVALUATION — It is time for the audio segment of the loudspeaker industry to consider training women engineers to evaluate sound of their products, suggested Paul Harpley, Oxford Electric. Women hear a higher range of frequencies than men, he explained.

Harpley demonstrated three loudspeakers to the 100 experts attending the meeting. He suggested that standardized testing equipment should be developed for rerating the loudspeakers according to the Walsh system. He added that this equipment should be generally available to the industry before dependable ratings can be universally applied.

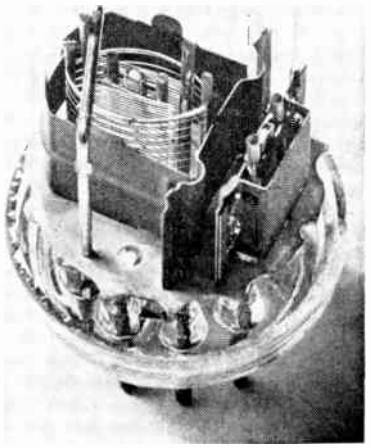
Improved Tubes Simplify Circuit Requirements

NEW frame grid tubes, used in tv sets, enable manufacturers to build more compact sets at lower prices, according to Amperex.

Used as a package, the two tubes give gains in excess of 200. When coupled with 6EH7 and 6EJ7, in a two-stage i-f system, tv set can achieve sensitivity of less than 5 microvolts for one volt at the detector. The third i-f stage can be eliminated.

The new tubes for vhf and uhf television sets are a 6HA5/EC900 triode amplifier, and a 6GJ7/ECF801 oscillator-mixer. The former utilizes grid wire 8 microns thick, said to be first time such small wire has been used successfully in mass produced entertainment tubes. Grid-cathode spacing is only 40 microns. Tube's transconductance is 20,000. In a standard four-circuit tuner, new tube provides about 2.5 db more gain and 0.8 to 1 db less noise than presently used type.

The triode-pentode oscillator mixer incorporates frame grid con-



CUTAWAY *view of oscillator-mixer tube, believed to be first to use two frame grids in both sections of triode-pentode*

struction in both sections, is said to be first mixer tube to use frame grids. Gain is 5,000, and 1.6 volts oscillator injection is required, which means it can be loosely coupled to minimize radiation problems. Oscillator can operate reliably at low line voltages.

Defining Mechanism Involved in Sputtering

FURTHER studies of the sputtering mechanism of gallium antimonide not only serve to elucidate the sputtering process, but may also provide needed information concerning the nature of atomically clean surfaces.

Up to now, sputtering of compounds has not been studied widely in detail, and has been discouraged by the inability to define completely the sputtering mechanism for simpler single element materials.

Workers at Mallory find gallium antimonide of interest because of an unusual crystallographic effect. S. P. Wolsky, D. Shooter and E. J. Zdanuk report sputtering yield data, atom ejection patterns,

and sputtered film composition that support a molecular sputtering mechanism for GaSb. Surface structure models are used to explain the atom ejection patterns. Selective sputtering has been noted for gallium. Considerable information has been obtained concerning the sputtering of diamond-structure materials.

Molecular Understanding of Cathodo-Luminescence

RARE EARTH oxides, combined with niobium oxide at high temperatures are cathodo-luminescent. That is, they emit light under bombardment by a beam of cathode rays.

Guided by molecular architecture, research arms of electronics seek to uncover laws of molecular arrangements to design any kind of material with foresight.

At Hirst Research Center, England, research worker above builds model of the probable arrangement of lanthanum niobium oxide. Aim: to build luminescent materials and devices to order.

Inset, below photo, shows x-ray diffraction pattern of a cathodo-luminescent compound, from which crystal information is obtained.

Photodetector Has Fast Response Time

SUBMILLIMETER radiation detector developed by Royal Radar Establishment, Malvern, England, re-

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electronic products for the telephone industry...

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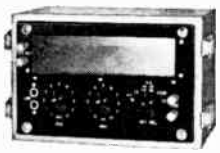
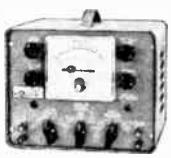
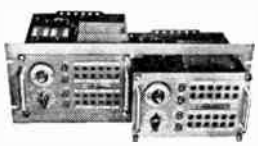
Simplifies cable acceptance tests and return loss measurements.



Far End Terminating Set
Provides precision network termination during cable testing.



Pulse Meter
Furnishes a convenient method of measuring dial speed and percent make.



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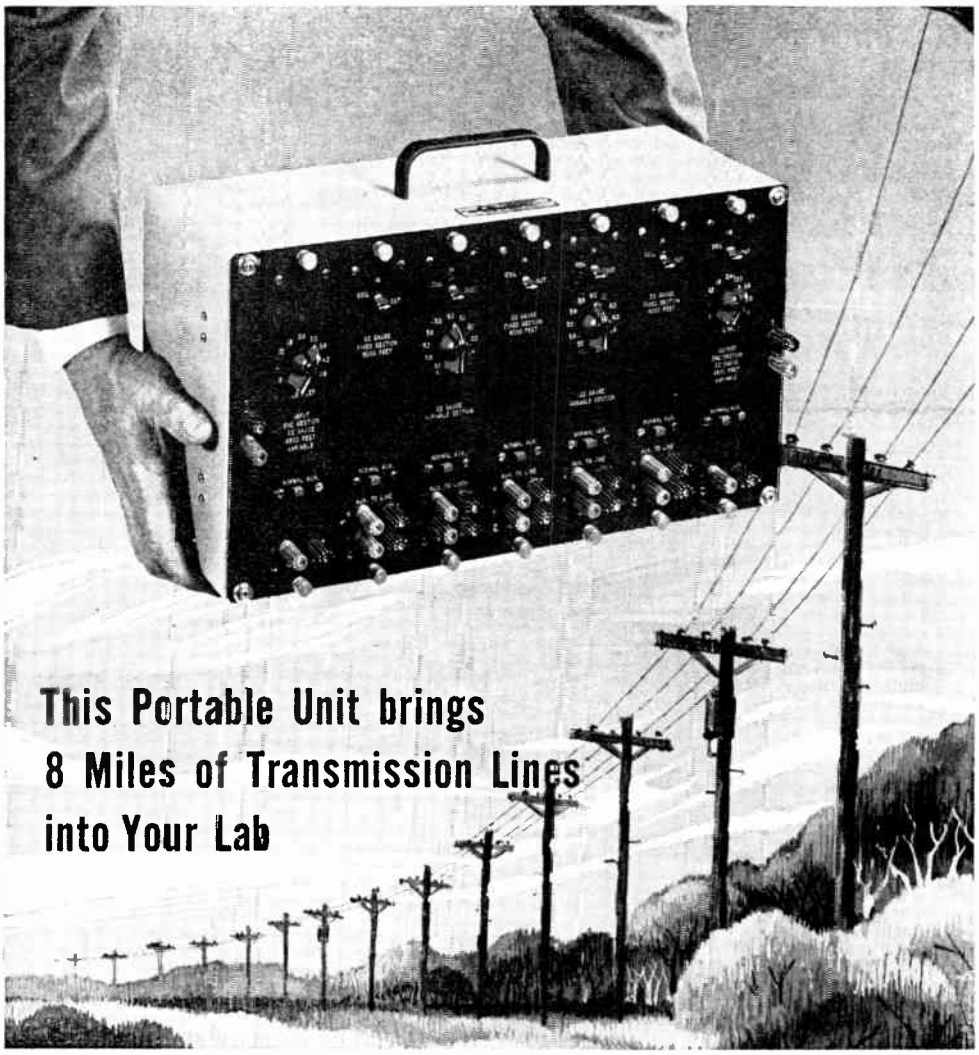

Eliminates the Need for Leased Lines

Wherever you have a requirement for transmitting information, data, and intelligence this portable equipment will simulate transmission lines right in your lab.

The standard unit simulates 8 miles of transmission line, but it can be modified for any line length required. Plug-in modular construction. Seven plug-in modules each simulate 6,000 ft. of standard telephone cable with loading coil.

The Airtronics Artificial Line meets field engineering requirements. Some time-saving, money-saving laboratory uses are for testing data transmission (offers loaded or unloaded test facility); for testing amplifier operation over telephone lines (permits actual frequency response measurement to be observed over a simulated line); for checking system gain requirements for a pre-determined frequency range; for simulating complex values of AC impedance and DC resistance as incorporated in telemetry circuit transmission; for training purposes (used exclusively by every major telephone company).

The Airtronics Artificial Line is available in 19, 22, 24 and 26 gauge.

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sponds in less than one millisecond. Time distribution of the radiated energy during a pulse generated from a plasma generator can now be measured.

Tube is being manufactured by Mullard London.

Other applications include microwave spectrometry, examination of resonances in large molecular bondings, absorption measurements in inorganic materials, maser phenomena, and detection of radiation from sun and moon.

Study of cloud formation and rain by direct observations at appropriate wavelengths is another possibility.

At present, device has wavelength range of 0.1 to 8 mm. In near future, this will be extended towards 0.01 mm or less by providing a range of doped germanium crystals which will be interchangeable with the indium antimonide element used now.

Semiconductor Radiation Mechanism is Clarified

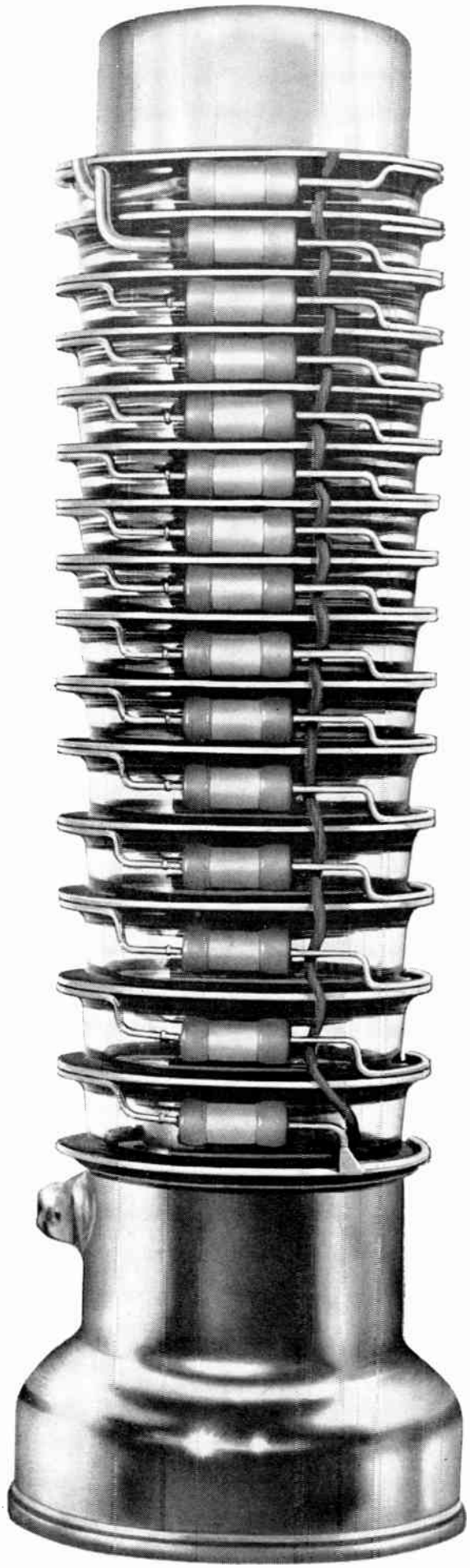
POTENTIONALLY useful approach for producing silicon or germanium semiconductors is described in a report for the U. S. Atomic Energy Commission[1]. Hydrogen compounds of silicon or germanium are used as starting materials. Effects of varying radiation was noted in this study. One aim was to decompose silane, and to some extent germanium, through a process of reducing the hydrogen content.

Attention was directed toward examining the effects of varying the temperature, pressure, surface-to-volume ratio in the reaction area and radiation sources to obtain a better understanding of the processes involved. Radiation sources included cobalt 60 and an atomic pile. A continuous process for decomposing silane to produce silicon is also included. A companion bulletin on radiation effects is also useful to investigators.[2]

REFERENCES

(1) Synthesis of Semiconductor Materials by Radiation Induced Reactions, Bulletin NYO 9864, OTS, U. S. Department of Commerce, Washington 25, D. C. ($1.25).

(2) Radiation Effects on Semiconductor Devices, LAMS 2706, OTS, U. S. Department of Commerce, Washington 25, D. C. ($1.75).



ASCOP multiplier phototubes

INSENSITIVE
to 400 G's during launch
SENSITIVE
from 1100 to 13,000 Å in orbit

Now, from the Princeton Division of Electro-Mechanical Research, Inc., comes a line of multiplier phototubes that are ideal for aerospace applications or other uses that demand a combination of brute strength and precise response.

ASCOP multiplier phototubes have proved themselves in many satellite applications, as well as in the rough-and-tumble environment of oil field exploration. Their unique vertebrate construction enables them to withstand up to 400 G's of shock and ambient temperatures as high as 150° C. Yet their range of spectral response is unmatched in the industry.

When you specify ASCOP multiplier phototubes, you have a wide range of choices which gives you almost unlimited application flexibility. You can choose, for example, from 22 basic models, or you can consult with EMR's technical staff on a design especially tailored to your application. You have a choice too among a wide variety of window material, including glass, sapphire and lithium fluoride. These materials matched with the proper photo cathode can give you a sensitivity from 1100 to 13,000 Å. You also have a choice of silastic rubber or other materials in which the voltage divider network will be encapsulated.

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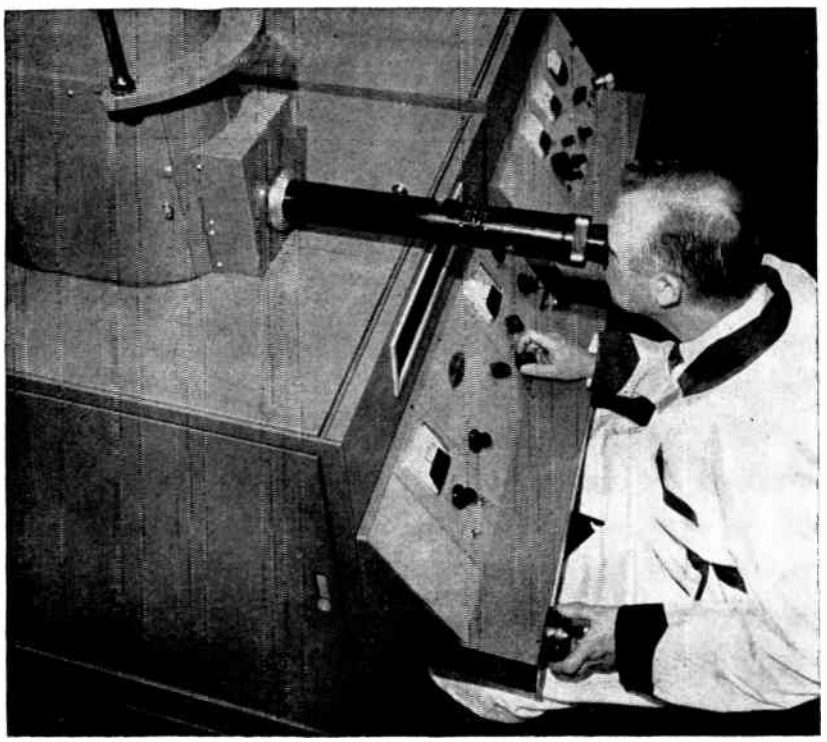
Electron Beam Cutting For Microelectronics

Microwelding techniques also may provide special fabrication processes

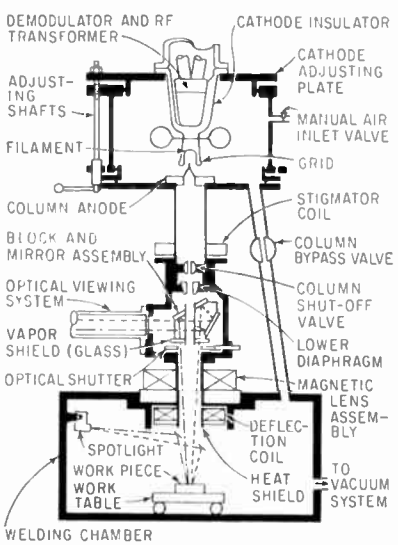
By F. L. SCHOLLHAMMER
Hamilton Standard Division
United Aircraft Corporation,
Windsor Locks, Conn.



ELECTRON BEAM *cutting and welding machine removes metallic material at selective evaporation rates*

ELECTRON BEAM cutting and evaporation processes are relatively new techniques, particularly to the electronics industry. Fabrication of thin film resistors and other devices by electron beam cutting and scribing techniques will help rapid expansion of the manufacture and use of microelectronic devices. Production equipment that provides both electron beam scribing and cutting together with microwelding capabilities will form the basis for special joining and cutting production processes in the electronics industry.

Recent advances in electron optics permit greater precision and cutting with the electron beam. Finer focus generates power densities in the order of 10^{10} watts per square inch, and greater ability to control beam deflection parameters results in accurate geometrical control of the cut. With such power densities cutting is done by evaporation of the workpiece. Beam deflection control can be achieved by use of sawtooth and/or sine-wave function generators that drive magnetic deflection coils located beneath magnetic focusing lens. In this way, numerous beam patterns can be followed during cutting—from a single spot source to a square or rectangular shape, including variations of Lissajous' figures.



ELECTRON OPTICS *refinements enable focusing of electron beam to produce power densities on the order of 10^{10} watts per square inch*

EQUIPMENT—A new model Hamilton-Zeiss electron beam cutter using an input voltage of 150 Kv provides beam current and accelerating potential control features that embody cutting and microwelding capabilities. Electrons are produced by heating an 0.008-inch diameter tungsten hairpin filament to approximately 2,500 degrees C. Surrounding the emitter is a cup-shaped bias control grid. The bias control provides initial beam shaping by means of an electrostatic field which forces the cloud of electrons emitted by the cathode into a cylindrical column. A negative bias voltage controls electron flow from the cathode.

The regulation of this bias voltage provides control of the beam intensity. Electron acceleration is provided by adjusting a high potential difference (50 to 150 Kv) between the anode and the cathode. By judicious selection of accelerating potential, cathode bias, pulse width, and pulse frequency, a wide range of power settings can be made as required by the particular cutting application. With electromagnetic focusing, minimum beam diameters range from approximately 0.001 inch at maximum

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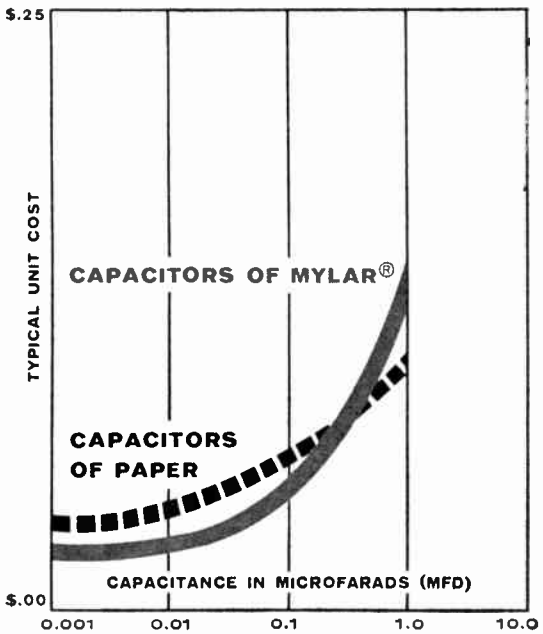

You may not realize it, but you can benefit from the higher dielectric strength, moisture resistance and reduced size of capacitors of "Mylar"* polyester film without paying a premium price. An industry study of manufacturer prices shows THAT OVER A RANGE OF SIMILAR CAPACITANCES AND RATINGS, UNITS OF "MYLAR" COMPARE CLOSELY IN COST WITH THOSE OF PAPER.

According to a recent survey, few engineers are aware of this close price comparison . . . although they recognize the outstanding properties of "Mylar". Look into it yourself. Before specifying capacitors for your design, get this free booklet study with performance facts and price charts. Write: Du Pont Co., Film Dept., Wilmington 98, Delaware.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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power to less than 0.0005 inch at lower power. The beam can be pulsed from approximately 0.1 to 16,000 cycles per second. With the magnetic deflection coils, beam deflection can be accomplished over an area of ¼-inch square on the workpiece in accordance to programming of the beam by the sawtooth and/or sine-wave function generators.

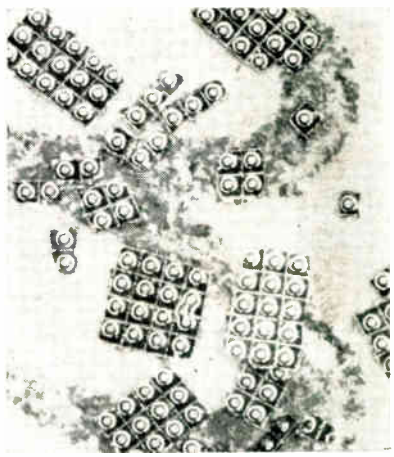
A binocular optical viewing system permits accurate location of the beam prior to the cutting operation and also allows the operator to inspect and view the cutting process. Its zoom-type lens permits magnification variation of 14× to 40×. The workpiece is mounted on a table which operates in an X and Y direction. All drilling, cutting, and microwelding operations are conducted in a vacuum of approximately 5×10^{-5} Torr.

PROCESS—Despite very high operating temperatures, only the material immediately adjacent to the area being cut (or evaporated) is affected. The heat-affected zone is held to approximately 10 percent or less of the width of the cut. Intermittent rather than continuous electron bombardment minimizes the temperature rise in the surrounding material because the workpiece actually cools between bursts of electrons. The beam off-to-on ratio is at least 10 to 1, or greater, which means the electron beam is on no more than 10 percent of the total time.

DRILLING APPLICATIONS — Ceramic wafers (96 percent alumina) 0.010 to 0.025-inch thick have been cut at a rate of 25 inches per minute. Edge roughness obtained from this cutting operation is approximately 0.0005 inch. The width of the slot at the top and bottom was within a tolerance of +0.001 inch. Slots 0.005-inch wide can be cut on 0.010-inch centers. To obtain this close spacing, a special cutting technique is used.

A series of adjacent holes is drilled as the initial operation. After the holes are drilled, the remaining ceramic webs between the holes are scanned with the electron beam until a free and open slot is obtained. Thermal input to the ceramic wafer is controlled by selectively deflecting the beam using a line scan generator or sine-wave generator to eliminate the possibility of cracking the basic ceramic between slots. An optimum evaporation rate, without undue heat input to the ceramic wafers, results with a scanning rate of 1,200 cycles per second and the use of tungsten run-off tabs on the ceramic at each extremity of the deflection sweeps. The tabs protect the ceramic from the extreme temperatures due to beam dwell at the maximum deflection point. Copper heat-sink blocks have been used successfully.

CUTTING APPLICATIONS—Perhaps one of the most interesting and immediate applications of the electron beam cutter to the electronic industry is the cutting of micro diodes. A density of 10^4 diodes per square inch is obtained



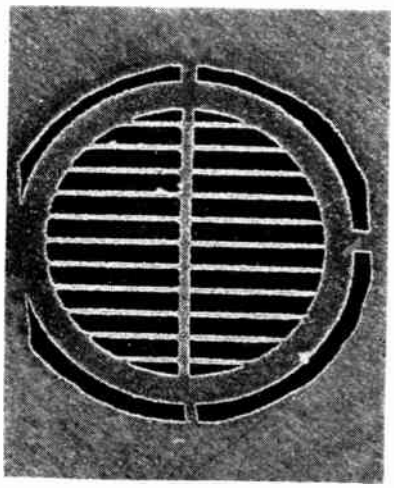
MICRODIODES *diced by electron-beam scribing number 10^4 per square inch*

by the conventional thermal diffusion and chemical etching process. After chemical etching, the respective diodes must be cut, mounted, and encapsulated. Isolation of the individual diodes can be readily accomplished by using the electron beam cutter for scribing the surface between the respective diode nucleii. Separation of the individual diodes from the sheet can then be accomplished mechanically or ultrasonically.

Another immediate and practical application of electron beam cutting to the electronic indutry is in thin films. A 0.020-inch-thick quartz wafer with a 100-angstrom-thick vapor-deposited titanium film was

scribed to resistance values of 20 and 40 kilohms. The width of the electron-beam-scribed cuts is approximately 0.0013 inch; however, scribed lines as narrow as 0.0007 inch have been achieved.

In another practical application, a traveling-wave-tube grid was cut from 0.002-inch OFHC copper foil using an electron beam programmed by a flying spot scanner. The negative used in the flying spot scanner was approximately a 10:1 magnification of the actual part. The electron beam pulse power supply is triggered by the scanner's photocell. The scanner's cathode ray tube is coupled in series with the deflection coils in the electron beam machine. Consequently, as the cathode ray beam scans the negative, the electron beam within the cutter follows a smaller field of view on the workpiece. Whenever radiation from the cathode ray tube impinges upon the photocell through a light area in the negative, the cutter beam is energized and the material from the area in question is vaporized on the workpiece. The linear



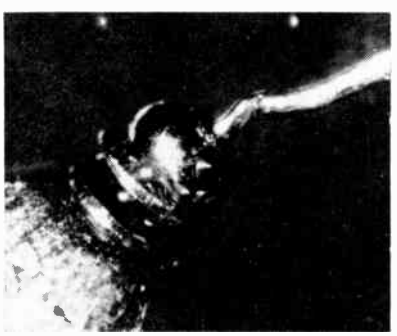
GRID *for traveling-wave tube was cut from copper foil by a flying-spot-scanner controlled electron beam*

ratio of reduction from negative to workpiece can be varied from 8:1 to 16:1, i.e., a two inch diameter pattern can be reduced to a range of $\frac{1}{4}$ to $\frac{1}{8}$ inch diameter. Furthermore, since the original (before photo reduction) artwork of the parts to be machined can be up to 100 diameters the size of the original part, very intricate shapes can be machined.

High speed cutting of magnetic

tape by the electron beam offers a new technique for preparing or processing magnetic tape for high precision aerospace instrumentation requirements. A 0.0015-inch Mylar magnetic tape with iron oxide on one side and graphite on the other was cut at speeds up to 15,000 inches per minute. The machined edge obtained from electron beam cutting compares favorably with the edge cut by mechanical methods. The heat-affected zone of the cut edge is less than 0.0002 inch. The build-up or debris left at the cut edge is equal to or less than the debris left by the mechanical-knife edge cutting process which is limited to a maximum speed of 4,000 inches per minute. With reduced beam energies, the electron beam can be used to sensitize the magnetic tape; this process then lends itself as a writing tool instead of a cutting tool.

MICROWELDING — Under some conditions, the machine can be used for welding operations even in a pulsing mode, particularly when operating at higher beam energy densities. By defocusing the beam slightly, the effective beam energy density to the workpiece can be changed from an evaporation process to a melting process. It is advantageous to use beam pulses having a time duration of at least ten microseconds and beam pulse frequency of 10,000 cycles per second. Laboratory tests have demonstrated that the latter two machine parameters enhance fusion of the materials to be welded. A 0.006-inch gold wire was welded to the tip of a microdiode assembly. The wire was first bonded to the diode conductor by a thermal compression technique and the joint sub-

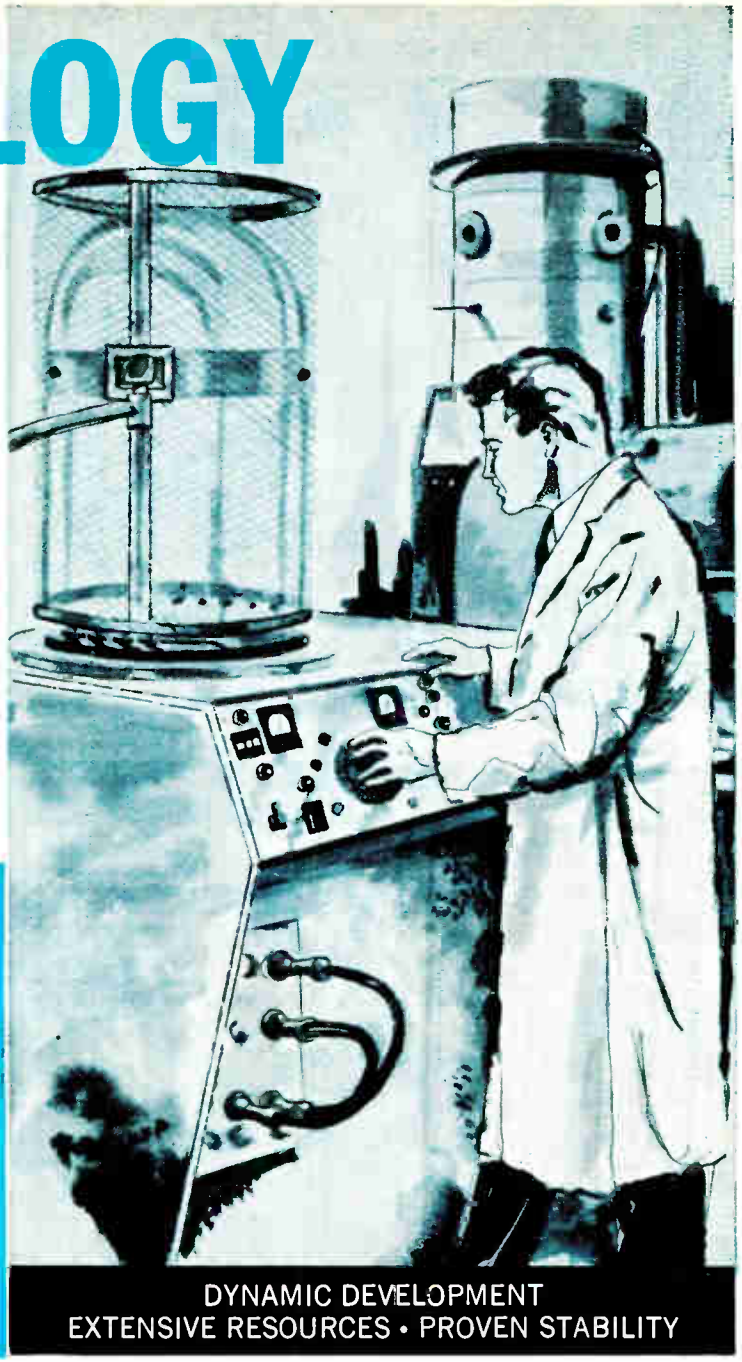


MICROWELDING *capability is demonstrated by welding of 6-mil wire to microdiode*

TECHNOLOGY

AND RESEARCH HAS MADE KINNEY THE WORLD'S LARGEST MANUFACTURER OF HIGH VACUUM EQUIPMENT

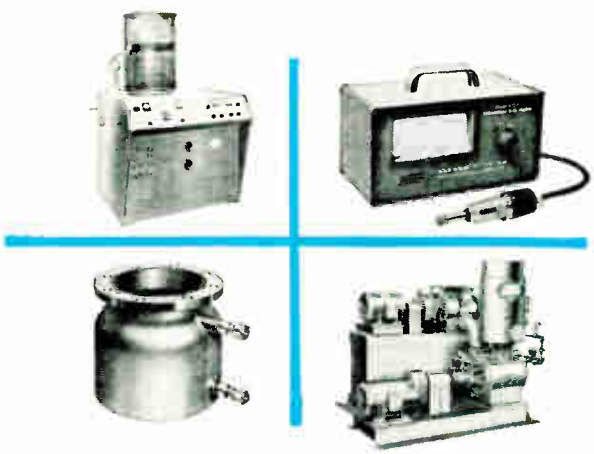
● The technical skill of Kinney Vacuum developed throughout the years; the technology displayed in the advancement of the vacuum pump; high vacuum pumping systems; and the many refinements in high vacuum techniques: all these matured capabilities are employed in the manufacture of each Kinney Vacuum product. Constant research and development plus careful reliability-control guarantee the entire Kinney line of mechanical pumps, diffusion pumps, valves, baffles, gauges, vacuum furnaces, space chambers and complete vacuum systems to be the most modern in design; efficient in operation, and constructed to give the maximum in service.



DYNAMIC DEVELOPMENT
EXTENSIVE RESOURCES • PROVEN STABILITY

HIGH VACUUM EVAPORATOR KSE-2

Modern and compact in design, KSE-2 provides rapid evacuation to 10^{-4} torr; ultimate pressures to 5×10^{-7} torr. It is an extremely useful laboratory tool in the areas of thin-film depositing, optical coating and metallizing. Other uses include freeze drying, cathodic etching, film dehydration and many others. The system is enclosed in a hammertone gray finished cabinet with a formica top working surface. All electrical controls are conveniently located on the sloping front panel.



KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET • BOSTON 30, MASS.

sequently welded with the electron beam to increase the reliability of the connection. The relatively large bead at the junction occurred in the thermal compression bonding process; the electron beam weld is located between the base of the bead and diode conductor. The assembly was then encapsulated by rotating the assembly under a slightly defocused beam pulsed at a frequency of 9,800 cycles per second.

Machine Fastens P-C Boards With Pins

TINNED COPPER PINS *replace eyelets in machine connection technique*

DOUBLE-SIDED printed circuit boards are interface connected by a machine technique that uses pins in place of eyelets or plated-through hole connections. Developed by GE's Heavy Military Equipment Department, the method is claimed to be less expensive, more reliable than present connecting techniques. The machine drives a 0.045 inch diameter pin through a 0.040 inch diameter hole in the board, after prescribed length-cutting of pins from a reel of hard drawn, tinned copper wire. Insertion rate is 30 pins per minute. Circuit board with predrilled holes is held beneath a spring-loaded locating pin in the locating head. Spooled wire is fed from the underside of the board by the feed mechanism. A simple cutoff device shears the wire into the required pin length. Pin is pressed through the board by an inserting rod. Flow soldering of both sides of the board completes the connection, but mechanical rigidity is not dependent on the solder fillet.

What's your *present* job in electronics? What will you be working on tomorrow? Do you know the latest electronic developments *outside* your particular specialty that may affect your work?

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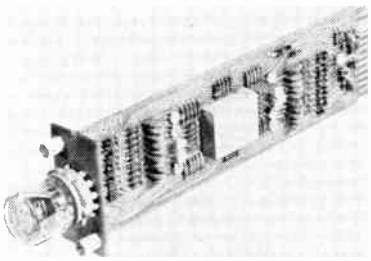
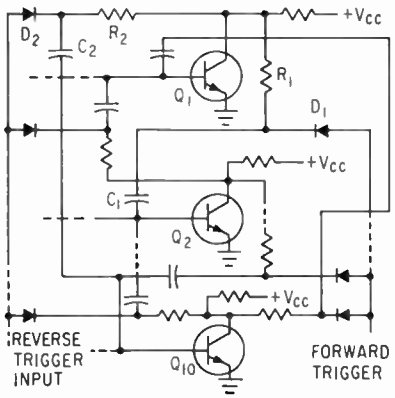
DESIGN AND APPLICATION





Solid-State Counter is Reversible

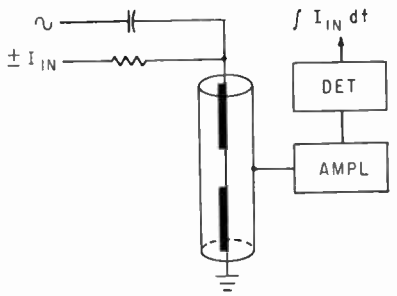
Counts forward and reverse at 10 Kc. Integral indicator tube is readout device

ANNOUNCED by Burroughs Corp., Electronics Components Div., Plainfield, N. J., the BIP-8002 solid-state reversible counter with integrally mounted Nixie indicator tube counts both forward and reverse to 10 Kc, reversing time of 100 μsec and carry delay of 0.5 μsec maximum. Input is 2 v negative with pulse width of 10 μsec. Reset is 35 v positive at 4 μsec pulse width. Output is from nominal +55 v to +1 v at 3 ma. The unit uses a Bipco module forming a 10-state storage register. Bidirectional counting is by preconditioning two capacitor-resistor-diode gates associated with collector of each transistor amplifier. As shown in the sketch, gates associated with Q_1 consist of R_1, D_1, C_1, R_2, D_2 and C_2. One gate connects to base of preceding stage and other to succeeding stage. Diode D_1 connects to forward trigger input and D_2 goes to reverse trigger input. With register in state 1, Q_1 saturates and other nine stages are off. Collector of Q_1 is at ground potential while other collectors are at +55 v. Since forward and reverse busses are normally at ground, all gate diodes are reverse biased except D_1 and D_2. Thus a positive pulse on either forward or reverse lines causes counter to step forward or reverse depending on which line is pulsed. Forward pulse turns on Q_2 through C_1 while reverse turns on Q_{10} through C_2. Once transistor turned on saturates, it remains so and holds other nine off through the diode matrix.

CIRCLE 301, READER SERVICE CARD

Analog Computation Readout Indicator

RECENTLY announced by Curtis Instruments, Inc., 351 Lexington Ave., Mount Kisco, N. Y., the model 5262F capacitive readout reversible integrator provides visual and electrical readout of the integral of any time-dependent function and has no moving parts. The device has symmetrically reversible integration, infinite memory of integral, −5 to +5 ma d-c input, direct visual readout, zero input threshold, not affected by superimposed ripple, linearity better than 0.1 percent, and integral output preamplifier and scaled electrical output. The device operates on electrochemical principles. The integrating element consists of a capillary tube filled with two columns (electrodes) of mercury separated by a gap of aqueous electrolyte. The d-c input signal electroplates mercury across the gap at a rate which is a direct function of amplitude of input signal, causing the gap to move. The outside of the capillary is covered by a



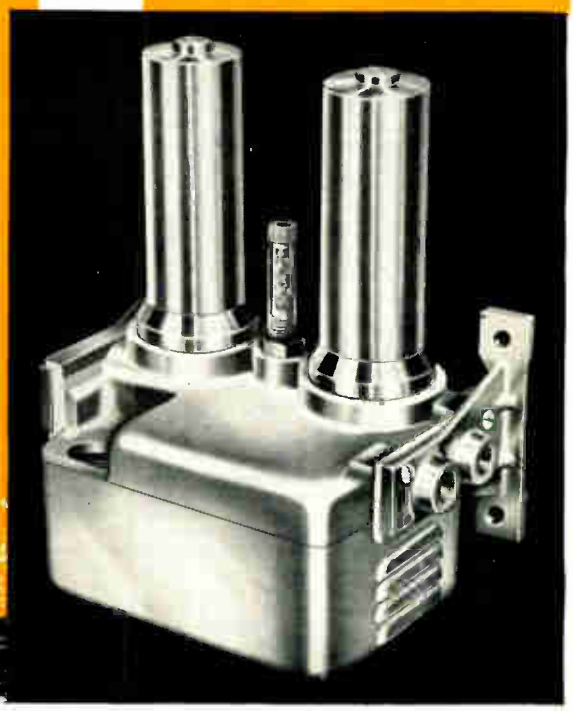
vapor-deposited conductive sheath. The mercury electrodes and sheath, separated by a glass wall, have 20 pF capacitance. In application, an a-c signal is connected across the electrodes and superimposed on the d-c input signal. With one electrode at a-c ground, excitation signal induces a voltage at the sheath which is a direct function of length of ungrounded electrode. **(302)**

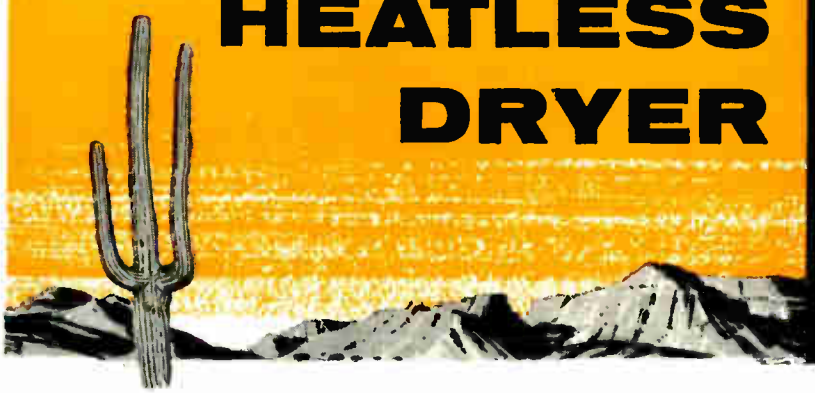
Silicon Junction Exhibits Negative Resistance

RECENTLY announced by Solitron Devices, Inc., P.O.B. 286, Danbury, Connecticut, the Negohm device is a silicon junction, two-port device that exhibits normal diode forward voltage-current behavior, sudden reverse voltage avalanche breakdown, and then negative resistance with further reverse voltage in-

NOW ULTRA DRY AIR OR GASES

at less than 25% of former costs with the GILBARCO HEATLESS DRYER





A NEW LOW-COST DRYER WHICH OPERATES CONTINUOUSLY WITHOUT MAINTENANCE OR SERVICE

Dewpoint? As low as — 100° F. Capacity? 1 to 7½ SCFM. Pressures? Up to 125 PSIG. Cost? About one-quarter of what you'd expect to pay. That's the new Gilbarco Heatless Dryer, a small compact, lightweight dryer employing a principle of operation developed and patented by one of the world's great research laboratories, Esso Research and Engineering Company. If you have need of ultra-dry air, there is no more economical or efficient way to obtain it than with this new Gilbarco unit. Write for catalog and complete information.

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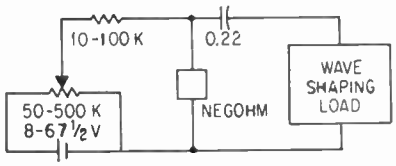
APPLIED PNEUMATICS DIVISION
GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASS.

SPECIFICATIONS

Model No.	HF-200-4	HF-200-6	HF-200-9	HF-200-12
Flow Operating at 100psig	1 SCFM	2½ SCFM	5 SCFM	7½ SCFM
Model No.	**HF-201-4**	**HF-201-6**	**HF-201-9**	**HF-201-12**
Flow Operating at 125psig	1 SCFM	2½ SCFM	5 SCFM	7½ SCFM
Weight (approx.)	4 lb.	5 lb.	6 lb.	7 lb.
Height (approx.)	9"	11"	14"	17"
Width (approx.)	8"	8"	8"	8"
Depth (approx.)	5"	5"	5"	5"
Power Requirements	110 volts or 220 volts, 50 cycles or 60 cycles, single phase 15 watts. Other voltages and frequencies available.			

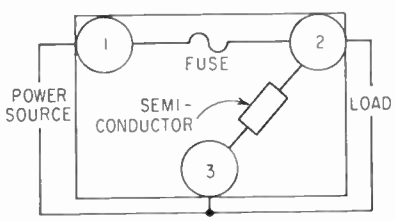
Models are available in accordance with MIL-E-16400 and qualified under the requirements of MIL-T-17113 and MIL-STD-167.

crease. Units with avalanche voltages from 5 to 40 v are available. When biased into the negative resistance region, the device can operate as an oscillator, low and medium frequency switch or any other function suitable to a device showing negative resistance. The



sketch shows a voltage-controlled oscillator having a sawtooth output (or near sine when load is paralleled resistor-capacitor and spiked when load is paralleled inductor-capacitor) with frequency from less than 100 cps to more than 100 Kc depending on time constant of load. Output voltage is minimum 8 v and device current is typical 100 to 3,000 μa. Output is more than 2 v rms into 100,000 ohm load. Frequency change with voltage is between 2:1 and 5:1. The unit has a positive temperature coefficient.

CIRCLE 303, READER SERVICE CARD

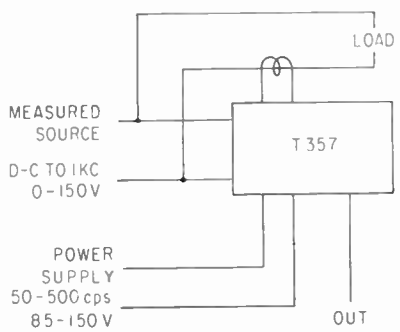


Protecting Transistors Against Overloads

MANUFACTURED by Littelfuse Inc., 1865 Miner St., Des Plaines, Illinois, the Transistor Protector is designed for transistor circuits where a single accidental application of overvoltage or current can destroy the circuit. The device can be mounted in a printed circuit board and the circuit is shown in the sketch. The load being protected is connected between terminals 2 and 3 and input power is applied to terminals 1 and 3. This provides both voltage and current protection to the load if the fuse and internal semiconductor combination are properly chosen. For example: a ¼-ampere fuse is used in conjunction with a 30-v turn-on semiconductor. The semiconductor will turn on in less than 1 μsec and prevent accidental overvoltage. If overvoltage persists, fuse will blow. The fuse also protects against overcurrent. Units are available with 20 to 200 v ratings with overload currents from 0.05 to 1 ampere. A glow indicator can be included to spot fuse failure. (304)

Power Computer Insensitive to Waveshape

NEW from Avtron Manufacturing Inc., 10409 Meech Ave., Cleveland 5, Ohio, the model T357 is a solid-state, four-quadrant multiplier that senses voltage and current being delivered to a load and produces a voltage proportional to magnitude



of load power. Range is to 500 w which may be increased with current or potential transformers with voltage between 85 and 150 v and current to 5 amperes. Frequency is 50 to 500 cps (separately excited is d-c to 500 cps), accuracy is 1-percent full scale with a-c and 2-percent full scale with d-c. Response time unfiltered is 100 μsec. Output is +0.5 v, +50 μa into 10,000-ohm load adjustable; positive for power flow from source to load and negative for reverse flow. Open circuit voltage is approximately 2.5 v. Two separate current circuits may be used to find sum or difference power in two circuits from same voltage source as a transistor time-division multiplier senses voltage and current flow. The current circuit is a 6-in. wire passing through a small toroid acting as a current transducer operating on a-c or d-c whose only losses are I^2R of wire resistance. The voltage circuit is also purely resistive and dissipates less

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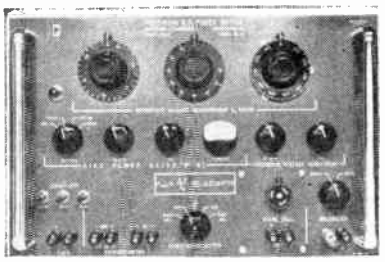
than 200 mw at 100 v. The sketch (p 88) shows a typical single-phase power monitor.

CIRCLE 305, READER SERVICE CARD



Precision Bridge Measures R-F Power

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model PB-1B may be used with a wide variety of bolometers for the precise measurement of high frequency and microwave power. It is capable of accuracies of 0.1 percent in the measurement of substituted d-c power. Unit can be used with any 100 or 200 ohm, grounded or ungrounded bolometer mount requiring between 3 and 15 ma of bias current. The bridge has a substitution range of 0.1 to 20 mw depending on the bolometer used. It sells for $2,350. (306)

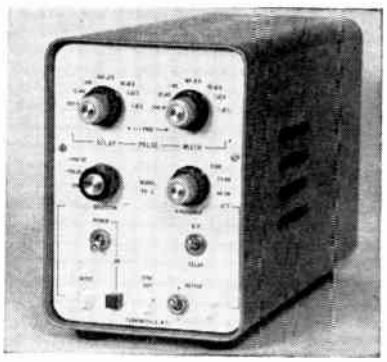
Voltmeter & Standard

MESUR-MATIC ELECTRONICS CORP., Warner, N. H. Model V DC-2BR, which combines in one portable cabinet a chopped amplified d-c voltmeter and an accurate Zener reference source, is available in ranges from ±0.5, 1, 3, 10, 30, 100, and d-c volts. (307)

Inertia Damper Used With Servo Motors

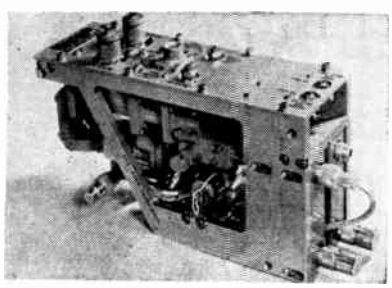
FEEDBACK CONTROLS INC., 8 Erie Dr., Natick, Mass. Model 124 inertia damper can be used with servo motors having rear shaft extensions in Bu Ord sizes 11, 15, and 18. The damper stabilization ratio

(alpha) is 14 or greater when used with these motors and low reflected load inertias. Even with reflected load inertia as great as the motor inertia, the value of alpha equals 10 or more. An advantage of dampers using a viscous fluid is that by changing the fluid the damper fine constants (break frequencies) and the gain-crossover frequency can be chosen by the designer. (308)



Unit Pulsers Weigh 7 Pounds

INTERCONTINENTAL INSTRUMENTS INC., 123 Gazza Blvd., Farmingdale, N. Y. Line of transistorized unit pulsers provides square waves, positive and negative pulses, and double pulses from d-c to 12 Mc. Width and delay variation is 30 nsec to 0.25 sec; rise and fall time is 10 nsec. Output provides 20 v from 50 ohms, with continuous adjustment to 20 mv. (309)

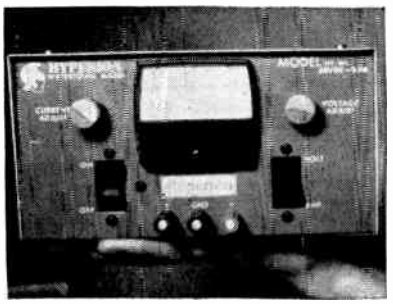


Parametric Amplifier Covers 2.7 to 2.9 Gc

AIRBORNE INSTRUMENTS LABORATORY, Deer Park, L. I., N .Y., offers a broad-band 2700-2900 Mc parametric amplifier designed to retrofit S-band radar systems for which fixed-tuned amplifiers are desired. Model 1230 has a noise figure of less than 3.5 db. Unit has two stages of parametric amplification, both being fed from a common

pump source. Gain stability is excellent, since each stage has a relatively small gain of about 10 db. Size is 12 by 6.5 by 4 in.

CIRCLE 310, READER SERVICE CARD



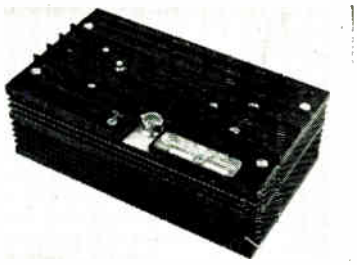
Lab Power Supply Features Compactness

HYPERION INDUSTRIES, INC., 127 Coolidge Hill Road, Watertown, Mass. Model HY-W1-30-0.6 is a compact laboratory power supply that is continuously variable from 0 to 30 v d-c at a load of 0 to 600 ma. Combined regulation against line and load is 0.05 percent or 5 mv, whichever is greater. Ripple is less than 1 mv rms and the response time is less than 50 μsec. Input power is 105-125 v a-c, 50-440 cps. Price is $129. (311)

TV Camera Tester Attaches to Lens Mount

PHOTO RESEARCH CORP., 837 North Cahuenga Blvd., Hollywood 38, Calif. Designed for the critical alignment and standardization of tv cameras, the Optoliner attaches to the lens mount of any studio or closed-circuit tv camera and accurately checks opto-mechanical alignment, sensitivity, and calibration to lab standards. It precludes the variables present with external test patterns through use of internal test pattern slides. Light level and color temperatures are adjustable, and even illumination without hot spots is provided by an exclusive integrating sphere. A photo-

cell measures light intensity on the face of the camera pick-up tube for precise sensitivity testing. (312)



Telemetry Transmitter Supplies 5W Power

VECTOR MFG. CO., INC., Southampton, Pa. The TRPT-5V rugged and ultrastable solid state telemetry transmitter is designed for missiles, space, and mobile applications. Output impedance is 50 ohms; frequency range, 215 to 260 Mc; frequency stability, ±0.005 percent; power output, 5 w; power input, 28 v d-c ±10 percent at 1.6 amp; temperature, −20 C to +80 C. (313)

Silicon Rectifiers

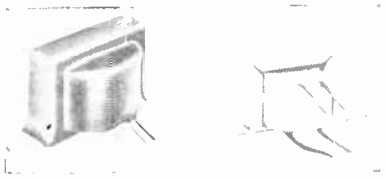
POWER COMPONENTS, INC., P. O. Box 421, Scottdale, Pa. Three new series of single junction, high voltage, silicon rectifiers are available with reverse currents down to 0.1 μa, in ratings of 0.5 amp, 0.75 amp and 1.0 amp, and piv's up to 2,000 v. (314)

Plug-In Power Supplies Consist of 25 Models

ACOPIAN TECHNICAL CO., 927 Spruce St., Eaton, Pa. Continuous duty at full load to 50 C ambient without additional heat sinking is a feature of the new 1.0 amp transistorized plug-in power supply series. Series G consists of 25 models covering output voltages from 6 to 30 v. An

internal adjustment of ±0.5 v is provided on all models. Input voltage is 105-125 v a-c, 50 to 400 cps. Output is floating. Line regulation is ±0.05 percent and load ±0.2 percent. Ripple is 1 mv rms. Size is 3⅝ in. by 4⅝ in. by 5½ in. Weight is 3¾ lb. Price is $95 each.

CIRCLE 315, READER SERVICE CARD

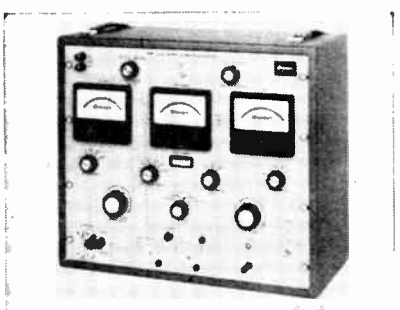


Transformers Used in Transistor Circuits

ADAM TRANSFORMER CO., INC., 1661 McDonald Ave., Brooklyn, N. Y., announces a line of 77 basic miniature transistor transformer types. They are used in diverse impedance matching applications in transistor circuitry. Primary impedances vary from 3 ohms to 500,000 ohms, secondaries from 3.2 ohms to 80,000 ohms with center-taps on many. Standard frequency response is better than ±3 db from 200 cps to 20 Kc. Power levels average from 100 to 350 mw. **(316)**

L-F Enclosure

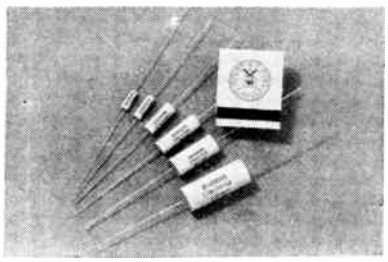
SHIELDING DIVISION of Shieldtron, Inc., Riverton, N.J., announces a new enclosure that provides magnetic shielding of > 35 db at frequencies as low as 60 cps. **(317)**



SCR Test Set Features Flexibility

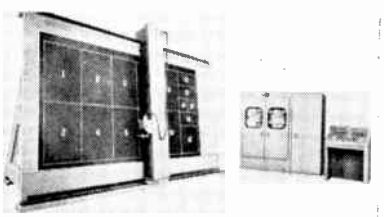
OWEN LABORATORIES, INC., 55 Beacon Place, Pasadena, Calif. Type 320-A scr tester is a complete facility for testing all types of Unijunction transistors, small as well as large

solid-state rectifiers, and all present types of silicon controlled rectifiers. Its wide range of voltage and current levels—peak forward currents of well over 300 amp and leakage test potentials to 1,000 v—make it extremely flexible. (318)



Miniature Capacitors Meet MIL-C-27287

DEARBORN ELECTRONIC LABORATORIES, INC., P. O. Box 3431, Orlando, Fla., introduces a line of miniature, fixed, plastic-dielectric, tubular capacitors meeting MIL-C-27287 (USAF). Operating over a wide temperature range of from −55 C to +125 C the units are designed primarily for filter, by-pass, and blocking operations requiring higher orders of reliability. Capacitance values range from 0.0010 μf through 1.0 μf in corresponding case sizes of 0.172 in. by $\frac{7}{16}$ in. to 1.15 in. by $2\frac{5}{8}$ in. (319)

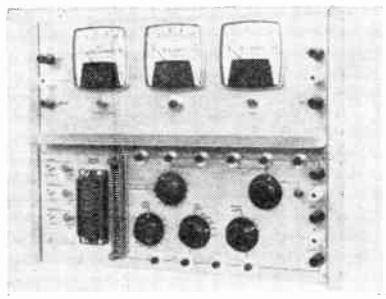


Plotting System Is Tape Controlled

THE GERBER SCIENTIFIC INSTRUMENT CO., P. O. Box 305, Hartford, Conn., has introduced a magnetic tape controlled plotting system, an instrument accurate to ±0.001 in. per ft over its 6 ft by 12 ft plotting area. The machine tool magnetic tape verifying system will perform the work of hundreds of draftsmen and maintain an accumulative accuracy of less than ±0.005 in. Capabilities include line drawing in four colors, typing and scribing information at rates up to 500 ipm. System may be

operated manually or automatically from its computer by means of magnetic tape.

CIRCLE 320, READER SERVICE CARD

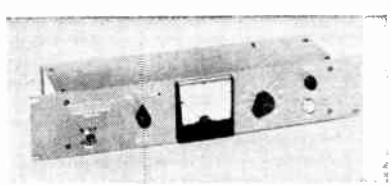


Module Tester Set Consists of Two Units

SCIENTIFIC DATA SYSTEMS, INC., 1542 Fifteenth St., Santa Monica, Calif. Model JX10 module tester consists of two units mounted in a single case. One unit measures the voltage/current parameters of switching and Zener diodes while they are installed in a circuit. The second unit tests complete cards under various conditions of loading, both resistive and capacitive, plus degradation of clock amplitude and width. Price is $3,000. (321)

Stud Base Rectifiers

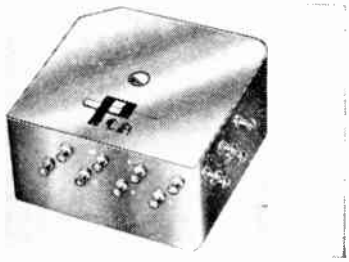
DELCO RADIO, division of General Motors Corp., Kokomo, Ind. The 1N3208 to 1N3212 series have a basic current rating averaging 15 amp over a temperature range of −65 C to +150 C; max prv ratings from 50 v to 400 v; max rms voltages from 35 v to 280 v; and withstand peak one-cycle surge current of 250 amp at 150 C case temperature. (322)



Ratemeter Offers 600,000 CPM Range

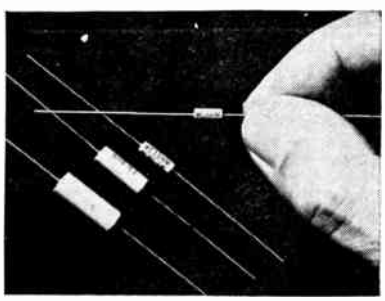
GENERAL NUCLEAR CORP., 538 E. Central Park Ave., Anaheim, Calif. Model 502 transistorized linear count ratemeter accepts negative pulses greater than ¼ v. Output is

presented on a 3-in. meter. Provision is also made to operate strip chart recorders. Range of the instrument is 600,000 cpm on eight ranges and features three time constants. Unit is also available with automatic range change and 500 to 2,000 v power supply. (323)



Chopper Transformer Is Ruggedly Built

PCA ELECTRONICS, INC., 16799 Schoenborn St., Sepulveda, Calif., announces a toroidal 28 v chopper transformer for application in a wide variety of transistorized power supplies. It has a chopper frequency of 2 Kc. The transformer is supplied with turret type terminals, and a through-hole capable of accommodating a 6/32 bolt. This transformer is ruggedly built to meet all applicable MIL T-27A specifications. (324)



Metal Film Resistor Made in Ten TC Codes

WARD LEONARD ELECTRIC CO., Mount Vernon, N. Y., has developed a $\frac{1}{10}$ w metal film precision resistor for use in computers, missile guidance systems, instruments and similar equipment. Type RN55 is designed to exceed MIL-R-10509C specs for Characteristics B, C, D and E. Units are manufactured in ten TC codes including T-9 (±25 ppm), with tolerances from the standard ±1 percent down to ±0.05 percent, and in a wide range of resistance values. (325)

Literature of the Week

PUSHBUTTON SWITCHES MicroSwitch, Freeport, Ill. Catalog 68a describes the new series 5 heavy duty sealed pushbutton switches.
CIRCLE 326, READER SERVICE CARD

A-C VOLTAGE REGULATORS American Rectifier Corp., 95 Lafayette St., New York 13, N. Y. Data sheet gives full specifications on Selenivac high power industrial a-c voltage regulators. (327)

MEASURING EQUIPMENT B&K Instruments, Inc., 3044 W. 106th St., Cleveland 11, O., offers a catalog on sound, vibration, and data analysis instrumentation. (328)

RESISTORS Key Resistor Corp., 321 West Redondo Beach Blvd., Gardena, Calif., has available a catalog, including five data bulletins on virtually its entire resistor line. (329)

MICROWAVE COMPONENTS Omni Spectra, Inc., 8844 Puritan Ave., Detroit 38, Mich. Brochure describes the Astroline series of miniature microwave coaxial components and the Terraline series of standard size components. (330)

SWEEPING OSCILLATORS Kay Electric Co., Maple Ave., Pine Brook, N.J. Bulletin describes the Multi-Sweep 121-A that covers from 0.5 to 1,100 Mc in frequency sweeps up to 300 Mc wide. (331)

ULTRASONIC TESTING Branson Instruments, Inc., 37 Brown House Road, Stamford, Conn. A 16-page booklet describes the Vidigage ultrasonic thickness tester. (332)

DIODES Clevite Transistor, 1801 Page Mill Road, Palo Alto, Calif., has released bulletins giving specifications, price and catalog information on a series of fast-switching, 4-layer diodes. (333)

PANEL METER Helipot Division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Style 43 panel meter with all-plastic case is being introduced in a 2-page data sheet. (334)

PROXIMITY TACHOMETERS Lectrologic of Florida, 4165 S.W. 11th Terrace, Fort Lauderdale, Fla. Catalog LC-300 describes a line of proximity tachometers with outputs covering the standard industrial d-c signals 1-5, 4-20, 10-50 ma. (335)

CONICAL SPIRAL ANTENNA American Electronic Laboratories, Inc., 301 Richardson Road, Colmar, Pa. Bulletin 62-7 describes a conical spiral antenna that provides a hemispherical radiation pattern with elliptical polarization for operation over wide bandwidths. (336)

TRIMMING POTENTIOMETERS Daystrom, Inc., Archbald, Pa., offers a technical data sheet on the 255 series

Squaretrim subminiature trimming potentiometers. (337)

TELEMETRY COMPONENTS Data-Control Systems, Inc., Danbury, Conn. Condensed catalog covers a full line of data acquisition and processing products and systems. (338)

PRESSURE TRANSDUCERS Servonic Instruments, Inc., 1644 Whittier Ave., Costa Mesa, Calif., has released seven new technical bulletins on pressure transducers. (339)

PLANT LOCATION West Penn Power Co., Cabin Hill, Greensburg, Pa., offers a booklet describing Western Pennsylvania in general terms as a location for manufacturing, warehousing and research facilities. (340)

GERMANIUM POWER TRANSISTOR Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J. Technical product bulletin lists specifications on type 2N2493 power transistor with 15 amp I_c. (341)

SILICON PROPERTIES MonoSilicon, Inc., 139 East 157th St., Gardena, Calif., has prepared an 11 in. by 17 in. chart in which "Resistivity versus Carrier Concentration" is depicted by curves. (342)

DIGITAL BUILDING BLOCKS Magnetics Research Co., Inc., 179 Westmoreland Ave., White Plains, N. Y. A 14-page catalog illustrates a line of transistor and magnetic core digital building blocks. (343)

DIGITAL VOLTMETER Dana Laboratories, Inc., 630 Young St., Santa Ana, Calif. Data sheet 48 covers the 4000 series, a four-digit all electronic digital voltmeter with one-digit accuracy. (344)

TIME DELAY MODULE Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. Two-page bulletin describes model 2825-502 solid state time delay module. (345)

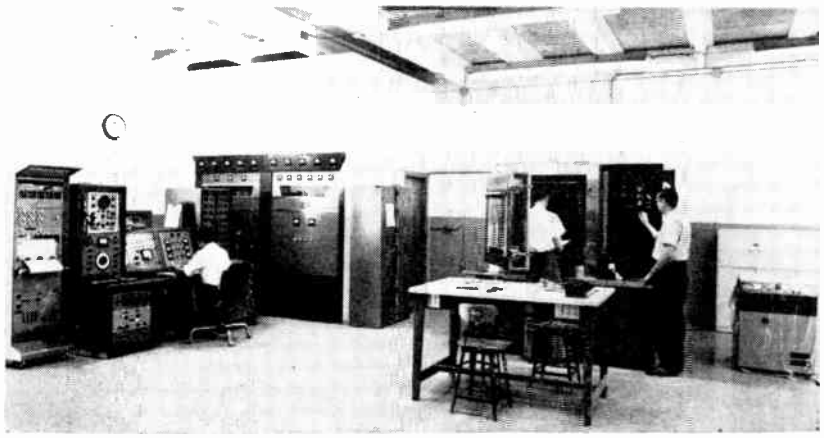
MINIATURE METERS The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, O., has published a data sheet describing its miniature meter, model 72. (346)

CONDENSED CATALOG Massa Division of Cohu Electronics, Inc., 280 Lincoln St., Hingham, Mass., has available a 4-page condensed catalog of its products and services. (347)

AEROSPACE SYSTEMS Systems Division, General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J., offers a brochure that presents a synopsis of its contributions to overall improvements in navigation, guidance, reference, and control systems since 1950. (348)

RIGHT ANGLE TUBE SOCKETS Aerovox Corp., New Bedford Division, New Bedford, Mass. Specification sheet 265Bl gives detailed materials and installation data on four types of right angle tube sockets. (349)

SILICON DIODES Fansteel Metallurgical Corp., North Chicago, Ill. Bulletin 6.356 discusses 50-w silicon Zener voltage regulator diodes. (350)



Test Facility Open to Industry

AVAILABILITY of its aerospace electronics testing services for use by other companies has been announced by Radiation Inc. of Melbourne, Fla. The $225,000 facility will provide environmental, electro-interference (rfi) and component evaluation test services on a priority basis second only to the owner's needs.

The engineering test services department, housed in a new 4,000 square foot building at Palm Bay can test components, subassemblies or systems.

The environmental engineering unit will perform such tests as vibration, shock, acceleration, temperature, temperature-altitude, humidity, salt-spray, rain and leakage. The environmental engineers also assist the designers through consultations and by evaluating test results.

Electro-interference instrumentation and measurement facilities capable of demonstrating compliance with electro-interference specifications are available for coverage from 30 cps through 10,000 Mc. Screen shielded rooms have input power-line filtering and sufficient shielding to satisfy the requirements of MIL-I-26600.

The components evaluation unit offers continuous evaluation of new or untested components, research to obtain or develop components to meet requirements, and inspection tests on incoming materials.

In addition to highly specialized test and evaluation equipment, Radiation provides more than 1,000 pieces of precision instrumentation to meet design, test and production requirements.

Wilson Assumes New Executive Post

RICHARD A. WILSON has been appointed vice president and general manager of General Dynamics/Electronics, Rochester, N. Y.

He joins General Dynamics from General Mills, Inc., where he was vice president of that company's electronics group since 1959.

Hazeltine Realigns, Adds Officers

R. L. BEAN, president of Hazeltine Corp., Little Neck, N.Y., has announced a regrouping and realignment of the various departments of the company's two major divisions to accomplish a further delegation of responsibilities for greater efficiency. This has resulted in the election of three senior vice presidents of Hazeltine Electronics division and a senior vice president of Hazeltine International division.

In Hazeltine Electronics division, J. W. Evans was elected senior vice president for marketing; J. W. Willenbecher, senior vice president for operations, and R. K. Hellmann, senior vice president for engineering. S. M. Thomas was elected senior vice president as head of Hazeltine International division.

A subsidiary of Hazeltine Corp., Hazeltine Research Corp., announced the election of Donald Richman and V. J. Young as vice presidents.

Hazeltine Corp., with 14 facilities throughout the country, is a leading electronics defense contractor.

Holmes Heads Hoffman Semiconductor Division

APPOINTMENT of Eugene A. Holmes III as vice president and general manager of the Semiconductor division of Hoffman Electronics Corp., Los Angeles, Calif., is announced.

Holmes formerly was vice president and general manager of the Autonetics Industrial Products division of North American Aviation.

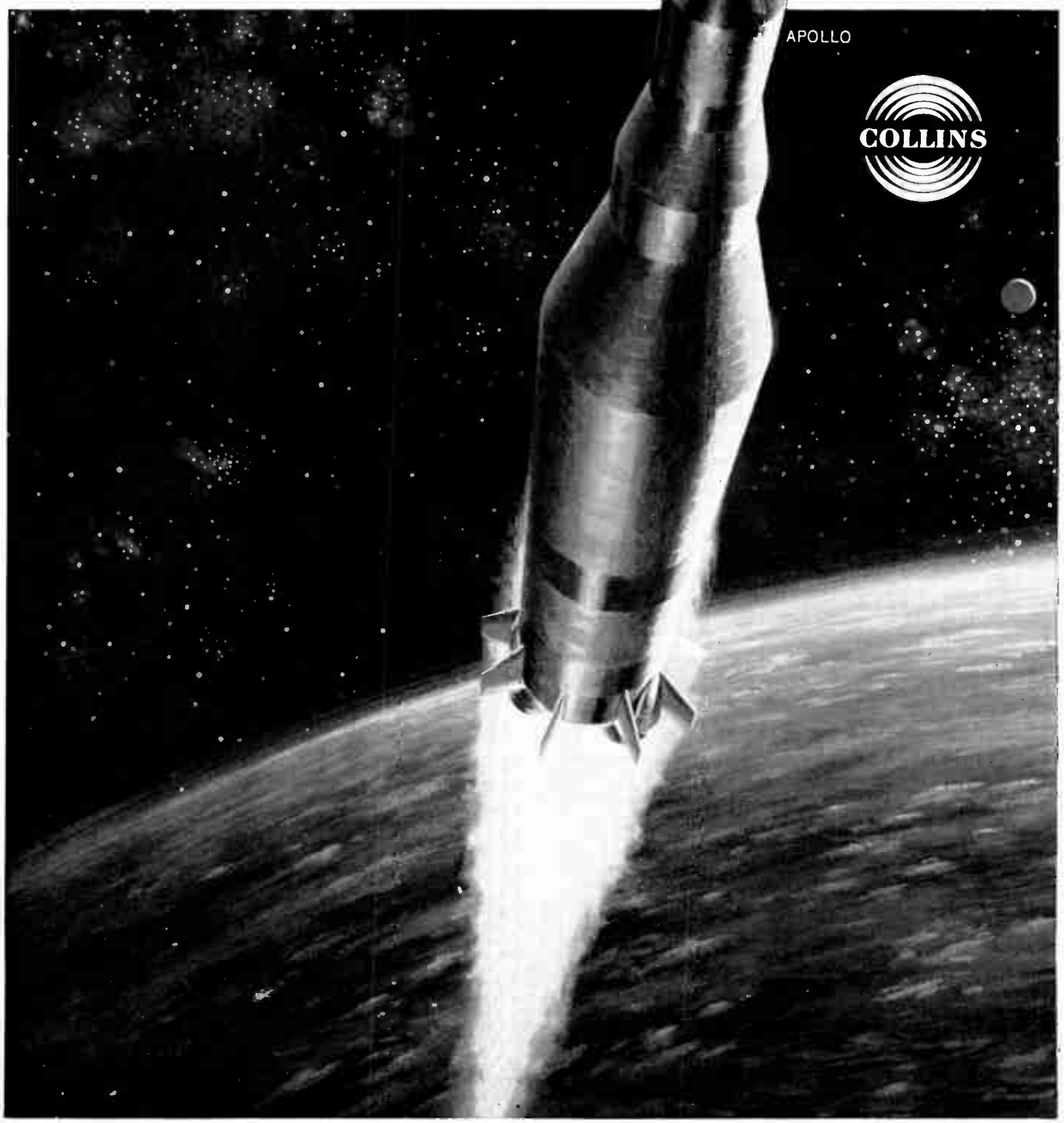
Elco Relocates Headquarters

ELCO CORPORATION, publicly-owned manufacturer of electronic connectors, recently relocated its Philadelphia headquarters with the opening of a new, 115,000 square foot, $1.25 million plant in Willow Grove Pa.

Built on a 10-acre site, the new structure will be the administrative

Collins communications careers point UP

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 you are the E.E., M.E., Mathematician, or Physicist who can grow with these projects, write Mr. L. R. Nuss, Collins Radio Company, Dept. EL, Cedar Rapids, Iowa.



and manufacturing center for a production complex that includes manufacturing installations in Pennsylvania, New Jersey and California as well as subsidiaries and licensees in five countries overseas.

Employing more than 600 people, the Willow Grove plant is designed to handle Elco's expanding volume of business which includes an order backlog of more than $7 million of which $5.75 million represents prime government contracts.

Elect Brumfield An AMF Director

RICHARD M. BRUMFIELD, president and co-founder of American Machine & Foundry Company's Potter & Brumfield division, Princeton, Ind., has been elected a director of the company.

President of P&B since 1947, Brumfield continued in that position after the company became associated with AMF in August, 1954. Since then, the firm has greatly increased its annual sales volume and has developed three new plant facilities in the U. S. and Canada.

Houston Fearless Promotes Luxenberg

HAROLD R. LUXENBERG has been named vice president for engineering at Houston Fearless Corp., Beverly Hills, Calif. He continues in his present position as assistant general manager in the company's Westwood division.

Luxenberg, previously with Ramo-Wooldridge and Litton Industries working primarily in information technology, first joined the Westwood division early in 1961 as reconnaissance systems head. Since that time he has held primary responsibility for technical direction on the entire Houston Fearless IAI program of information acquisition and interpretation.

General Time Names Egerton

APPOINTMENT of Henry C. Egerton as a vice persident of General Time Corp. and general manager of its Stromberg division at Thomaston, Conn., has been announced.

Previously, Egerton was general manager of the BullDog Electric Products division of the I-T-E Circuit Breaker Co.

Dale Accepts Sylvania Post

BRIAN DALE has joined the Semiconductor division of Sylvania Electric Products Inc., Woburn, Mass., as manager, advanced device research. He will supervise a group of engineers and scientists engaged in the design, development and pilot production of advanced semiconductor devices.

Before coming to Sylvania, Dale was associated with the Transitron Electronic Corp., where he was manager of theoretical and device research.

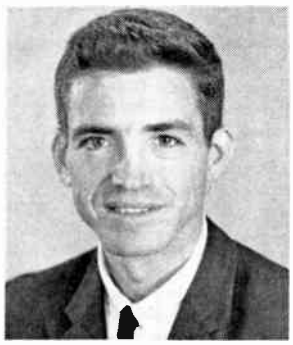
Diehl Manufacturing Fills Two Posts

TWO new positions have been created in the Electronics and Systems division of the Diehl Mfg. Co., Somerville, N. J.

Michael Bodnar has been promoted to chief electronics engineer. In this position he will supervise

all electronic product development work and systems engineering. Bodnar joined Diehl three years ago as a project engineer.

Rocco P. Caruso has joined Diehl as manager of electronics manufacturing. He was formerly quality control manager with the Daven division of General Mills.



Dynatronics Names Division Manager

MARVIN B. RUDIN has been appointed manager of Dynatronics, Inc., Data Development division in Orlando, Fla. Previously, he headed the systems analysis staff at Radiation, Inc.

As manager of data systems development — Dynatronics' largest engineering division—Rudin will supervise research and development of data processing systems and related telemetry and data communications equipment. The company has developed and built a variety of such systems which are a vital part of major U. S. aerospace test facilities.

Puckett Assumes Ortronix Post

H. E. PUCKETT has joined Ortronix, Inc., Orlando, Fla., as head of the newly formed Standard Products department. He will be responsible

for engineering specifications, applications, and marketing of the company's line of proprietary products.

Prior to taking the new position, Puckett was manager of applications engineering under the Products Department of Radiation Orlando.

Ortronix designs, develops and manufactures electronic and electromechanical systems, components and a line of products in the telecommunications area.

PEOPLE IN BRIEF

James Kubota leaves Bendix Corp. to join Omni Spectra, Inc., as staff engineer. **James A. Stark** promoted to mgr.-engineering for GE's Audio Products dept. **George B. Parsons** moves up to chief engineer at Skydyne, Inc. **Joseph B. Kennedy**, formerly with Hughes Aircraft Co., now senior development engineer at Microwave Electronics Corp. **Ernest F. Upton, Jr.**, advanced to v-p of engineering by Fischer & Porter Co. **Raymond A. Frey**, from Pacific Semiconductors, Inc., to the mfg. div. of Wyle Laboratories as program mgr. for life-test systems. Shure Brothers, Inc., promotes **L. Gunter** to chief engineer of the New Products dept. and mgr. of the Patent dept. and **R. W. Carr** to mgr. of the Applications Engineering section. **William E. Shoupp** and **Sidney Krasik** are elevated to vice presidents of Westinghouse Electric Corp. **Harry J. Watters**, previously with Polaroid Corp., appointed chief engineer, defense engineering, RCA. **T. Kenneth Riggs**, ex-Operations Research Inc., joins General Kinetics Inc. as staff consultant. Sterling Transformer Corp. promotes **Howard Pulver** to president. **Robert D. Miller**, formerly with Heil-Quaker Corp., named chief mfg. engineer for the Spinco div. of Beckman Instruments, Inc. **Col. M. R. Collins, Jr.** (U.S. Army, Ret.), appointed mgr. of the Space Systems div.'s product assurance program office at Lockheed Missiles & Space Co.

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5. Fill out the form completely. *Please print clearly.*
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BELL AEROSYSTEMS COMPANY Division of Bell Aerospace Corp. A Textron Co. Buffalo, New York	110	4
BRISTOL COMPANY Waterbury, Conn.	110	5
COLLINS RADIO COMPANY Cedar Rapids, Iowa	101	6
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JET PROPULSION LABORATORY Pasadena, California	109	10
MOTOROLA, INC. Chicago, Illinois	106	11
NATIONAL CASH REGISTER CO. Dayton, Ohio	110	12

(Continued on page 110)

(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)

12762

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	.....	.....
RESEARCH (Applied)	.....	.....
SYSTEMS (New Concepts)	.....	.....
DEVELOPMENT (Model)	.....	.....
DESIGN (Product)	.....	.....
MANUFACTURING (Product)	.....	.....
FIELD (Service)	.....	.....
SALES (Proposals & Products)	.....	.....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Some very successful companies are "sales oriented"—others, equally successful, receive their primary impetus from accounting, legal or business-management directions. Probably because of the highly technical nature of its product, Motorola has always been a company wherein engineering has been the moving force. At any management conference at Motorola, you'll find men think like engineers, and talk like engineers, because so many in the management echelon *are* engineers.

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- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstrom, traveling wave tube and backward wave oscillator
- Display and storage devices

2-WAY RADIO COMMUNICATIONS
- VHF & UHF receiver
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering

- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

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- **HF PULSE CIRCUITRY**
- **MULTIPLEXER DESIGN**
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- **SYSTEMS ANALYSIS**
- **TRANSMITTER, RECEIVER DEVELOPMENT**

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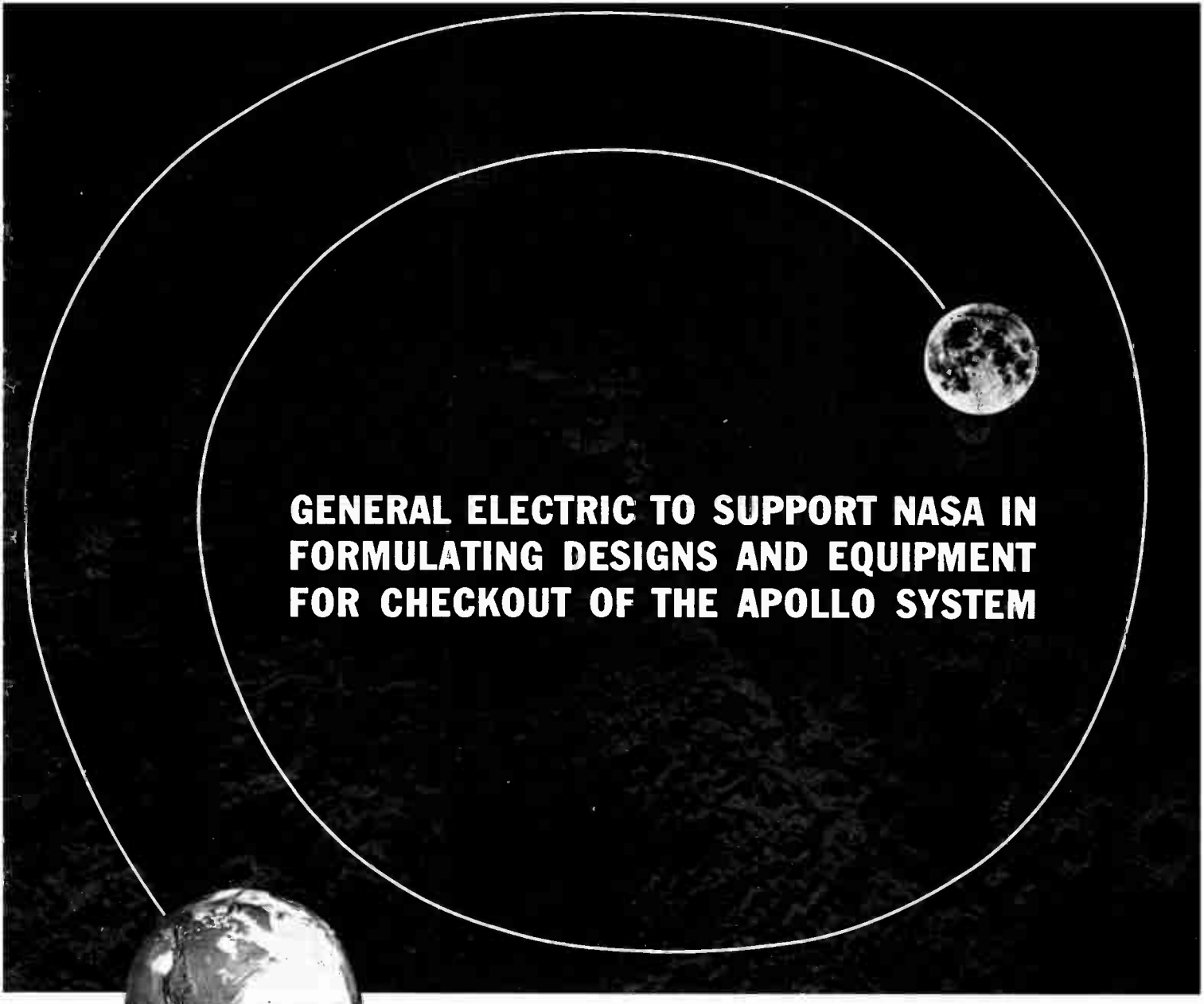

GENERAL ELECTRIC TO SUPPORT NASA IN FORMULATING DESIGNS AND EQUIPMENT FOR CHECKOUT OF THE APOLLO SYSTEM

The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

Assignments at HUNTSVILLE, DAYTONA BEACH, CAPE CANAVERAL and HOUSTON

Engineering experience required in
SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

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If you have experience in any of the listed areas, write us today (include salary requirements). Your inquiry will be held in strict confidence. Write to: Mr. P. W. Christos, Professional Placement, Section 69-WY, Apollo Support Department, General Electric Co., Administration and Engineering Bldg., Daytona Beach, Florida.

APOLLO SUPPORT DEPARTMENT

GENERAL ELECTRIC

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PROFESSIONAL CAREER PROGRESS REPORT NO. 3

by DICK RYON (BS Physics 1950), Project Leader, Data Instruments Department, Apparatus Division

Dick Ryon explains functional details of this nanosecond digital module he designed and developed for a high-speed pulse generator — one important item in TI's standard industrial product line.

"I joined Texas Instruments in 1957, after serving with one of the world's most highly-regarded electronic experimental laboratories where I aided in development of transistorized digital computers. Most engineers seek assignments that challenge their technical capabilities, provide adequate recognition and opportunities for advancement. These requirements have been fulfilled for me at TI.

UNUSUAL FREEDOM GRANTED

"I've experienced unusual design freedom on all my assignments and have been fully supported with skilled assistants and excellent tools, facilities and test equipment.

"The numerous and interesting TI projects I've conducted have been highly diversified — ranging from 2 cycles/second linear circuits to digital circuits utilizing 100 MC clock rates.

STIMULATING WORK ATMOSPHERE

"Close association with qualified specialists in state of the art circuit design, systems design and product engineering is a stimulating experience. It provides a pleasant work atmosphere and has helped materially to advance my career.

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"I urge any engineer or scientist seeking fascinating new assignments that will challenge his creative capacity to consider a professional career with Texas Instruments—where recognition and reward are in direct relation to the ingenuity and enterprise you display."

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- ☐ DIGITAL AND ANALOG CIRCUIT DESIGN
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- ☐ LOGIC DESIGN
- ☐ MAGNETIC AND PAPERTAPE SYSTEMS
- ☐ MECHANICAL DESIGN
- ☐ MEMORY SYSTEMS
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TEST INSTRUMENTATION (BS, MS) Development of measurement techniques and equipments using strain grids, X-ray, magnetic circuits, electrohydraulic servo systems and other physical principles to improve control and measurement of more than 100 rocket variables; i.e.: develop a method to determine accurately the instantaneous mass rate of discharge of a rocket motor.

DATA CONVERSION (MS)
Design and improvement of solid-state logic circuits used in high-speed multiplexing and analog-to-digital-conversion of data acquired by instrumentation.

DATA COLLECTION (MS)
Development of systems to acquire and analyze high-frequency dynamic data including spectrum analysis and three-dimensional data presentation.

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Every few hours, we get stacks of data. Right now, we're recording the cruise phase. December 14th, it'll be the encounter phase... including the actual scanning of Venus. And then we may very well continue our data handling until the Venus probe becomes a truly ancient Mariner.

As we write this, we already know more about solar plasma effects...the magnetic field in space...high energy and radiation...the distribution of cosmic dust in interplanetary space. And we're getting closer to knowing more about the temperature of Venus' surface...the amount of water vapor in Venus' atmosphere...how its atmosphere affects its surface temperature...the exact nature of Venus' cloud structure, and where, if at all, breaks appear.

As you read this, Mariner II has brought us millions of miles closer to perhaps millions of truths. Nevertheless, we're still only at the beginning. Which is where you come in.

If.

If you want to *know*. What's under Venus' cloud layer? What's the moon made of? Where else does life exist? What does tomorrow feel like?

Send us your resume. Together, maybe, we can work toward the day when no question will snow us.

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