A McGraw-Hill Publication 75 Cents January 25, 1963

electronics

NOT A GIANT HAIRDRIER

It's a Blue Scout nose cone with a new antenna, p 64

(photo right)

WHY USE A RING COUNTER?

Here's breakeven data on ring vs binary, p 44

NEW EM FIELD MAPPING SCHEME

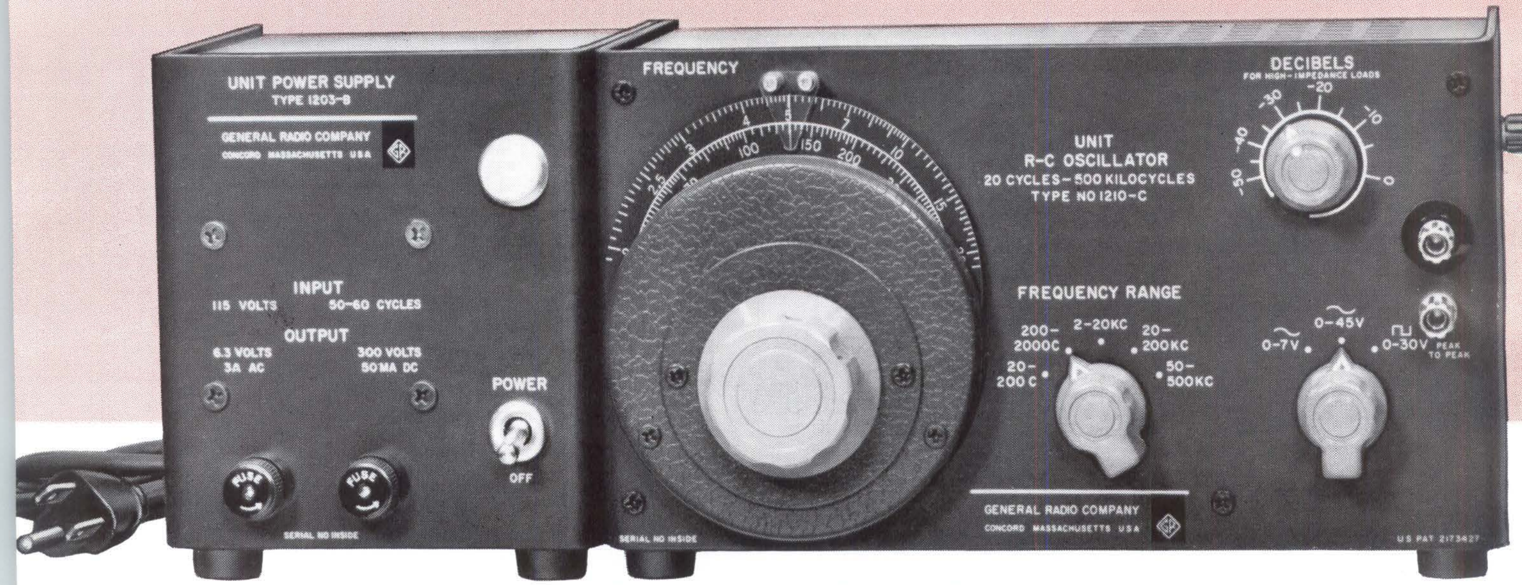
Light modulation means no leads to probe, p 39

PICK THE BEST CONNECTION

Big table rates eighteen methods, p 50

3 oscillators in 1

with the turn of a switch



Type 1203-B Unit Power Supply, **$50.**

Type 1210-C Unit R-C Oscillator, $180.

With this versatile R-C oscillator you have a choice of three outputs:

SINE WAVE, **Low-Impedance** — for loads of 500 ohms and higher. Maximum open-circuit output is 7v. Output constant within ±1 db to 200 kc; distortion less than 1.5% over entire range; hum down 60 db.

SINE WAVE, **High-Impedance** — for loads of 10,000 ohms and higher. Maximum open-circuit output is 45v. Output constant within ±1 db from 200c to 150 kc; distortion less than 5% from 200c to 200 kc; hum down 60 db.

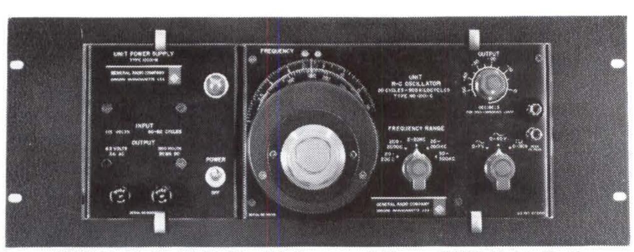
SQUARE WAVES — 0 to 30v peak-to-peak; rise time about ⅓ μsec; overshoot approximately 1%; hum down 60 db.

Other Features

- Very wide frequency range — 20 cps to 500 kc in 5 ranges.
- Calibrated output control (0-50 db).
- Fast-responding AVC system holds amplitude of oscillations constant.
- Sweeping of any frequency range using optional dial drive.
- Small, compact, lightweight and rugged.
- Low in cost — high in value.

Write for complete information

Type 1210-C can be converted to a sweep oscillator by adding a G-R Synchronous Dial Drive. **Type 908-P1 Drive** sweeps one frequency decade in 70 seconds. $35.



Type 1210-C Unit R-C Oscillator and Type 1203-B Unit Power Supply shown relay-rack mounted using Type 480-P4U3 Relay Rack Panel ($12.00).

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CIRCLE 900 ON READER SERVICE CARD

January 25, 1963

electronics

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electronics

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CONTENTS continued

DEPARTMENTS

CROSSTALK

HOW TO UNSPECIALIZE. When Associate Editor Shergalis returned a few days ago from a trip to Florida that included the IRE Millimeter and Submillimeter Conference, in Orlando, he groused about the weather—too cold for swimming after the day's work—but he had warm words for the conference.

Shergalis has been to many conferences (he's one of our farthest-flung editors) and, frankly, some of them were dogs. But the millimeter meeting, he says, was a pleasure: lots of news, and a feeling among the participants that they are in a lively, interesting and expanding field.

Some of these impressions spilled into the report on the conference that we published last week. But to make the deadline, the report had to be rushed through—by air express, telegraph and, at the last minute, tied together by Shergalis in Florida and the editor in New York with a phone call. So there wasn't much chance for discussing the more personal aspects of the conference.

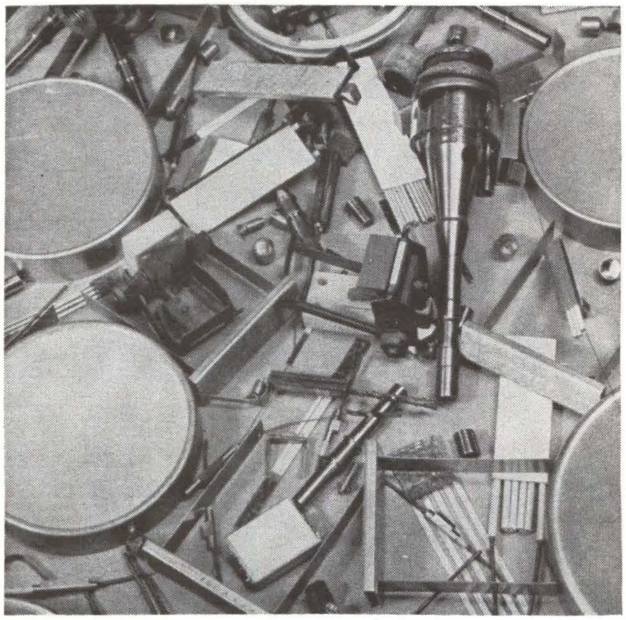
Nobody at the conference complained to Shergalis of being in a rut. That engineers have to specialize has been the complaint of many technical people in the electronics industry. Engineers that specialize can become limited in their views and often they can't appreciate the worth of technical advances in allied fields. They could even miss the boat on possible applications of new developments, seemingly divorced from their speciality.

But one of the things that keeps millimeter and submillimeter researchers hopping is that it is hard to specialize. This field has one of the broadest technical bases. Almost every physical phenomenon must be investigated for possible application to the problems of generating, detecting and transmitting coherent energy at millimeter frequencies.

The broad scope of his work, says the ultramicrowave engineer, is both a challenge and a frustration, but it is not boring. He must be a jack of all trades in applied physics.

The ultramicrowave engineer must understand the theory, be able to convert it into something practical, know where he can buy the best components and equipment at the best prices, and be a diplomat in order to argue his views with fellow ultramicrowave engineers.

Typical of the subject areas that must be investigated are classical electronics, quantum electronics, solid-state devices, ferrites, superconductors, optics, electromagnetism, acoustics, relativistic physics, plasma, spectroscopy, and precision metalworking methods.



And most of all, he must be able to communicate his ideas on any one of these things to engineers with interests as broad as his own.

REDUCING THE ERRORS. Werner Heisenberg's celebrated "uncertainty principle" states that it is impossible to obtain accurate measurements of, say, position and velocity, because the very process of taking measurements changes these values. For example, we can't watch an electron in orbit, because the reflected light we would need to see it would disturb the orbit.

This same sort of situation arises in taking field-pattern measurements for high-frequency antennas. The probe disturbs the field pattern being measured. Even if the probe is minute, its leads are usually long enough to counteract all the care taken in shrinking the probe. Obviously the best method is to use no probe—that would solve the lead problem, too.

As yet nobody has put this ideal solution to practice. However, Keigo Iizuka, of Harvard, has gone a long way in the right direction. He uses a probe, but dispenses with all connecting leads. The basic idea, detailed in our lead technical feature this week on p 39, is to use a tiny probe and detect its reradiated energy.

COMMENT

Reliability

We wish to express our sincere appreciation for providing us with thirty copies of the article, Reliability: 1962, by John M. Carroll (p 53, Nov. 30, 1962).

Because of the excellent content of the article, we wished to give it the widest possible circulation among our engineering and quality control personnel, as expeditiously as possibly, which we accomplished due to your prompt response to our request.

NICHOLAS J. MIGLIACCIO
Quality Control Division
Newark, N. J., Air Force Contract Management District
Air Force Systems Command

On Behalf of Lab Courses

I tend to disagree with your editorial of Dec. 14, 1962 (p 3). Based on my own experiences here at Rensselaer, I feel labs serve a very good purpose. First, let me make the qualifying statement that all E.E. labs, with the exception of special reports, are performed and written up during the time alloted for lab work. This does mean no endless evenings spent on reports, which I agree is wasted time.

I found it very helpful to have basic theory enhanced by lab work. I have plotted plate characteristics of a pentode, and torque curves of a series motor. That old adage, "seeing is believing," is very applicable when a student first confronts and is confronted with basic theory, particularly when more time is devoted to performance of the experiment.

Upperclass labs are even more helpful. Depending on the amount of theory a student has mastered, he is free to do whatever he wants in a certain area. (Example: Experiment on Logic—EE Lab III. Some students built and tested AND, OR and NOR gates. Others built and investigated complete logic circuits, utilizing flip-flops and any other number of basic circuits. Grades were given on the basis of originality and performance of work attempted.) Thus these labs can provide an excellent aid to the mastering of basic theory.

PAUL CHERECWICH, JR.
Rensselaer Polytechnic Institute
Troy, New York

Pulse Transformer Design

I've just read the article, Recently Derived Graphs Simplify Pulse Transformer Design, by Dan M. Bowers, in your Nov. 2 issue (p 52), and I must point out that the equation for calculating the impedance $Z_t = e_t R/(e_f - e_t)$, is in error.

Since the circuit contains both resistive and reactive components, the voltages in question cannot be subtracted arithmetically. Instead of the term $(e_f - e_t)$, another term has to be substituted: e_r, the voltage across the resistor.

CYRILLE POUCH
Freed Transformer Company
Brooklyn, New York

Author Bowers replies:

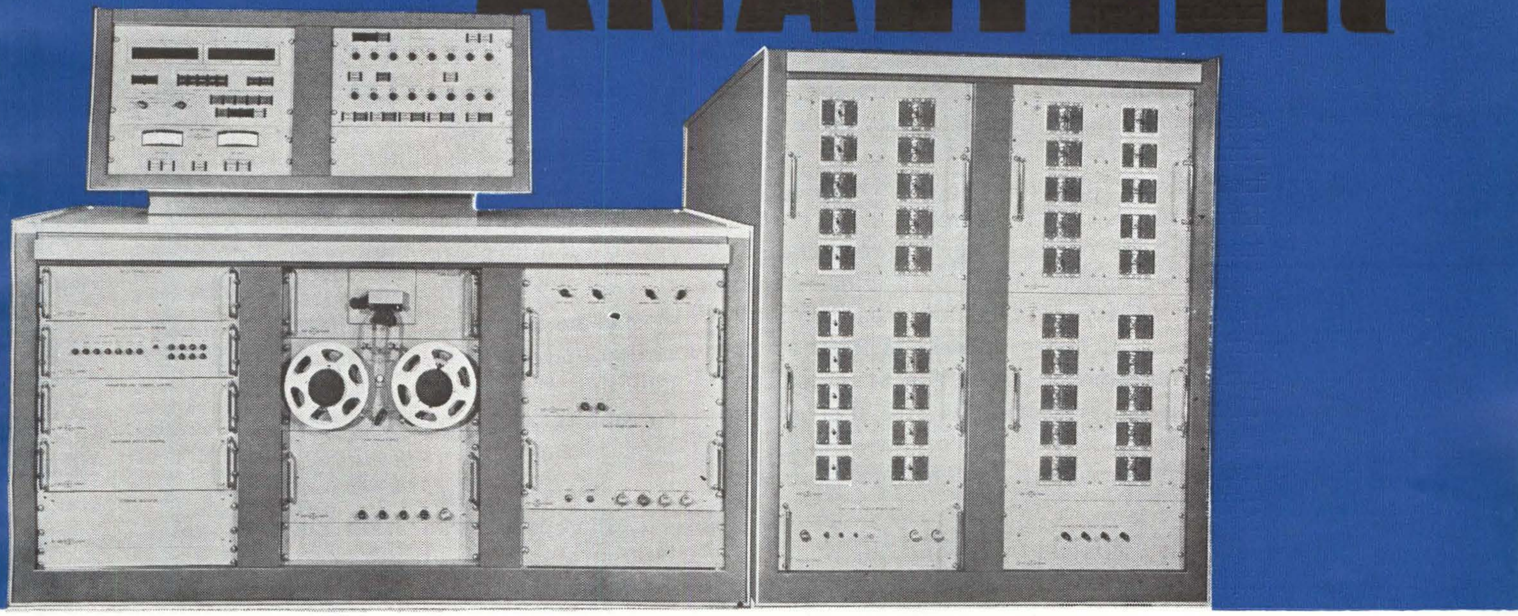
On a theoretical basis, reader Pouch's point is well taken; that is, due to the reactive nature of the circuit, $e_f - e_t = e_r$, is not a true statement. As a practical matter, however, the maximum phase shift over the frequency range of interest is a little more than 3 degrees, and the error introduced thereby is less than 0.4 percent.

Considering that the method described in the article is graphical in nature, and that the error resulting is of such a magnitude as to be nearly imperceptible in a slide-rule calculation, I must conclude that the equation used in the article is not, in the practical sense, erroneous. (These calculations are based on $R = 5K$; they obviously increase nearly five times in significance if the $R = 1K$ graph is used. The phase-shift effect may be seen in the graphs, in the article, as the divergence of the lines for $R = 1K$ and $R = 5K$.)

It may be of interest to note that the equation in question was adopted because, as a practical matter, the values e_f and e_t are more easily measured with an oscilloscope than is e_r.

DAN M. BOWERS
Computer Control Company
Framingham, Massachusetts

NEW GENERATION AUTOMATIC CIRCUIT ANALYZER



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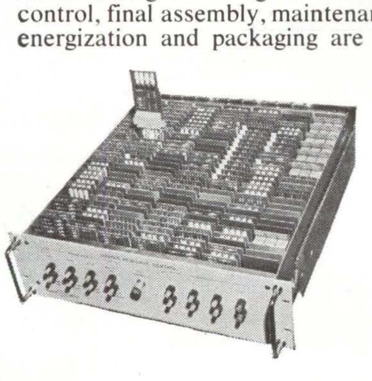

DIT-MCO also manufactures the Model 720A Automatic Logic Circuit Tester and a complete line of Automatic Circuit Analyzers, proven in use by leading aircraft and missile manufacturers.

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A modest proposal

In selecting a microwave signal generator, we urge you to ignore the "specification race". Give or take a split hair, each manufacturer's *performance* specification is conspicuous only by its similarity to the others. We say this despite the fact that many of our signal generators have led the pack in this frantic race for years.

The numbers game is fun to play, particularly when one is so often ahead, but we cannot, in good conscience, urge you to choose a Polarad Generator merely because it has a few megacycles more range, a wider choice of prfs, more linear frequency modulation, or even an intriguing and exclusive operational feature or two.

We propose, instead, that you go *beyond the specification* and ask: "How is this performance achieved? . . . How long will this instrument continue to perform within specification? . . . How much will it cost to maintain in perfect working order? . . . What percentage of the time will it be out of service for repair and recalibration?" Isn't each of these criteria at least as important as the performance specification? Of course it is *You want and need to buy the instrument that is very well designed and very well built . . . not just very well specified.*

We say this: look beyond the specification, at the instrument itself. Examine the panel critically — but then take off the cover, and look inside. In a Polarad Generator, you will see:

- The highest quality components, generously derated. (You may be surprised at the distinguished labels that flunk this simple test!)
- The meticulous craftsmanship that is uniquely essential to precision and stability in microwave instrumentation (you'll find no "bailing-wire" mechanics here!).
- Non-contacting-short cavity tuning, for complete freedom from noise, wear, and frequency skip or drift.
- Clean, modular layout, rugged construction, and an advanced thermo-mechanical design, ensuring rock-solid stability despite hard usage and repeated environmental stress. (Polarad Generators are the *"work-horses"* of the industry.)

It is no accident that Polarad is consistently selected to furnish microwave signal generators for the toughest, most reliability-conscious programs. We design them and build them so that the finished instrument is as impressive as the specification.

Call your Polarad Field Engineer today. Ask him to show you the quality of our instruments.

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4.2 — 11.0 KMC. Accurately calibrated absolute power-level. Adjustable from 0 to –127 dbm from 1 MW.

MODEL	FREQUENCY KMC	CALIBRATED POWER OUTPUT	INTERNAL MODULATION
PMR	0.5 - 1.0	0.5 MW (—3 dbm) to —127 dbm	Ultra-linear FM modulation standard sq-wave, 25-10,000 pps } with optional plug-pulse, 10-10,000 pps } in pulse modulator
PMX	4.45 - 11.0 (2 plug-ins)	1 MW (0 dbm) to —127 dbm	All instruments in this group: pulse modulation: 10-10,000 pps. *pulse width: 0.2-10 µsec. pulse delay: 2-2,000 µsec. square-wave modulation: 10-10,000 pps. FM deviation: ±2.5 MC min.
MSG-34 (Ultra Broadband)	4.2 - 11.0 digital freq. indicator	1 MW (0 dbm) to —127 dbm	
MSG-1R	0.95 - 2.40	1 MW (0 dbm) to —127 dbm	
MSG-2R	2.0 - 4.60	1 MW (0 dbm) to —127 dbm	*0.3-10 µsec. in MSG-1R and 2R.
KSS (Signal Source)	1.05 - 11.0 (4 plug-ins)	Uncalibrated Power Output: 14-400 MW, depending on freq.	sq-wave, 10-10,000 pps (external pulse, sq-wave FM)

HAVE YOU MADE RESERVATIONS YET?

Polarad's new "Project Mohammed" is now bringing the "Mountain" (our new Mobile Microwave Calibration Laboratory) to "Mohammed" (your microwave instruments). Be sure to take advantage of this opportunity to have your gear checked — at your doorstep. Save weeks of delay and needless expense. Call your Polarad field engineer for details and schedules!

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NASA Center Boosts Boston's Space Aims

BOSTON—Boston area's drive to become a center of space research (p 24, Nov. 2, 1962) will get a major push if Congress approves a $5-million appropriation in the proposed NASA budget (see p 18). The money is to start an electronics research center that would make this area the center of electronic component development for space.

Franklyn W. Phillips, director of NASA's North East Office, announced the center would be on equal level with Goddard, Lewis, Ames and other NASA centers. It would be the 15th such center.

Plans are to buy a 1,000-acre site, house the staff in temporary quarters until the center is operational. By 1967, there would be a staff of 2,000 in a $50-million facility. They would concentrate on developing components, allied physical sciences and, probably, auxiliary power sources. Emphasis will be on in-house research, although some contracts will be let.

The center will be located near the Boston-Cambridge university community to tap electronics research talent in that area.

MIT is planning to build a $4-million interdisciplinary center for space research, with NASA supplying $3 million of the cost. Phillips said the two centers would act independently, but would complement each other.

Meanwhile, Boston civic and industrial leaders are still making plans for a company to seek large NASA prime contracts for the area.

Japan Acts to Control Its Rising Tv Exports

TOKYO—The Japan Machinery Exporters Association (JMEA) set up a tv-export committee last week to maintain orderly exports. Misao Matsuda, business manager, said that exports to the U. S. increased so rapidly last year that the committee was organized to prevent a repetition of problems encountered in transistor radio exports.

Matsuda said that Japan exported $12.5 million worth of tv sets between January and October 1962, more than triple the exports in the corresponding period of 1961. But exports to the U. S. alone soared more than 400 percent.

JMEA is an official organization that handles most machinery exports from Japan, including radio and tv sets. In 1961, JMEA handled $1.1 billion, a 22-percent increase over 1961.

Radar Computer Maps Storm Height and Size

WEATHER RADAR data processor that automatically and almost immediately produces digital maps showing intensity and height of storms was described this week at the American Meteorological Society meeting by David Atlas, of Air Force Cambridge Research Laboratories. Called Stradap (Storm Radar Data Processor), the system enables maximum radar intensity and echo height to be displayed within five-mile squares.

Atlas reported that, in its first test in severe storm conditions late last year, Stradap detected and displayed a storm that produced a tornado in Charlton, Mass. Atlas said a network of 100 long-range radars and Stradap units could provide automatic storm-mapping for the entire country. Built by Budd Electronics, and based on Atlas' idea, the computer is tied to conventional weather radar.

Laser Radar Sweeps Can Indicate Size of Target

BEAM-SWEEPING technique being developed by Sperry Rand may enable long-range laser radar to make precision measurements of target size and to discriminate between targets and clutter.

Each 500-microsecond pulse of the laser beam is to be deflected through a known angle, alternately horizontal and vertical. Duration of the returns reflected from the target will provide angular width and angular length of the target. Angular presentations, multiplied by target range in a computing circuit, would give numerical readout of target size.

The deflector presently in development is a series of ½-inch-long bar-shaped optical prisms made up

Japanese Mission to Moscow: Sell Instruments

TOKYO—Japan International Trade Promotion Association will sponsor an instrument show in Moscow from July 22 through August 5. Displays worth about $2 million from about 100 Japanese firms will be shown. Approximately 60 to 70 Japanese technicians and businessmen will accompany the exhibition to Russia.

The Association is hoping that the USSR will buy one-third of its instrument requirements from Japan. A spokesman said that some of the participating companies might bring their instruments back to Japan rather than sell them in Russia. Fear of being copied is one reason given.

Instruments for measuring, communication, controlling, and medical purposes will be displayed. Most will be units developed using Japanese technology exclusively; very few or no units made under technical agreements with other countries will be sent, it was reported of wedge-shaped sections of potassium dihydrogen phosphate. Varying a voltage applied to a prism varies its refractive index and the exit angle of the laser output beam passing through the prism.

The technique was revealed yesterday in Sperry's quarterly *Engineering Review*, by Robert D. Kroeger. It is expected to find application in earth-to-space, space-to-space and high-altitude airborne laser radars.

Mach-3 Jetliner Demands New Electronic Gear

FAA HAS ALREADY set up a committee to study what electronic equipment a proposed supersonic air transport (see p 12) would require. Led by the FAA's Joseph K. Power, the committee hopes to complete its initial report sometime this year.

Power told ELECTRONICS that existing military equipment will be examined for clues as to what is wanted. For instance, the B-58's flight management system has "certain parts we like very much," Power said, although there are other parts that would be of no use to a commercial airliner.

Other items for study are a fully automatic landing system and the longer range radar needed for such a high-speed airplane. Cost estimates will not be possible until the committee nears the specifications stage, Power said.

France Plans to Build $100-Million Tv Net

PARIS—Government-owned broadcasting organization, Radiodiffusion Television Francaise (RTF), plans to spend $100 million over the next four years to equip a second nation-wide television network.

Although the existing network will continue broadcasting on the French 819-line standard, for its new network RTF will shift to the European 625-line standard. That opens the door to eventual color broadcasts, which RTF plans to start in the late sixties. For color, the European countries have agreed to adopt a common 625-line system, but have not yet decided whether to use the French SECAM or the American NTSC systems.

The new French network, industry observers generally feel, will add new kick to already brisk tv sales. Last year, tv set production in France hit 1 million units, up nearly 22 percent over 1961. Also, some 3.5 million existing sets would need adapters for 625-line reception.

Short-Range Cloud-Height Sets Sought by Air Force

BEDFORD, MASS.—Technical proposals are due February 18 on 65 cloud-height sets (AN/TMQ-14) to be purchased by Air Force Electronic Systems Division, Hanscom Field, for the 433-L weather system. Air and truck transportable systems will be for tactical operations. The basic sensor is optical, but information will be processed electronically and displayed by crt. Optical triangulation method will be used to detect cloud height at maximum range of 2,000 feet.

French Jets Will Use New Low-Ceiling ILS

SANTA MONICA—An initial order for 20 automatic landing systems has been received by Lear Seigler for use in Sud-Aviation's French Caravelle jetliners. Delivery is scheduled for October.

The new device—recently tested in France by FAA and its French counterpart—allows jets to land automatically under weather conditions of 100-foot ceiling and ¼ mile visibility. Presently, landing minimums are 200-foot ceiling and ½ mile visibility in Europe and 300-foot ceiling and ¾-mile visibility in U. S.

Although the system is now used only with LSI flight control systems it can be used with others. One feature is an instantaneous vertical velocity sensor that links ground control signals with the autopilot. There are also lateral and longitudinal couplers and a throttle control. During the final few seconds of flight, a radio altimeter regulates rate of descent.

In Brief . . .

ADVANCED NUCLEAR GYRO contract has been awarded to American Bosch Arma by Air Force (p 48, Dec. 28, 1962).

FURTHER DEVELOPMENTS in display technology (see p 24), particularly small area techniques, are expected from Navy R & D pact to be let February 12. G E, Sylvania and Lear are rumored to be among the bidders.

INERTIAL GUIDANCE system for the X-20A Dyna-Soar underwent its first test flight recently at Eglin AFB, Fla. Equipment was carried in the nose of a jet 'Voodoo' aircraft.

HUGE, AUTOMATIC data communications switching center (Mar. 2, 1962, p 26) has gone into operation at Tinker AFB, Okla. It is the third of five such centers to be activated.

AVNET HAS PURCHASED controlling interest in Production Technologies, Inc., Jamaica, N. Y.

GENERAL INSTRUMENTS will build a thermoelectric generator for the AEC. It will produce electricity directly from the unrefined waste of nuclear reactors.

COMMUNICATIONS SUBSYSTEM for the AF's mobile, mid-range ballistic missile is being designed by Sylvania, as part of Martin's overall command and control system design.

PHILCO has an $8-million Air Force contract to build data processing and display system to provide semiautomatic compilation and output of surveillance and tactical data at Alaskan long-range radar sites and automatic processing, display and re-transmission of data at four NORAD control centers and NORAD's Alaskan region combat center.

NASA WILL HOLD its second Industry Program Plans Conference February 11 and 12. Advance registration forms are available from room 50058, NASA headquarters, 400 Maryland Avenue, SW, Washington, D. C. No mail requests for forms will be honored.

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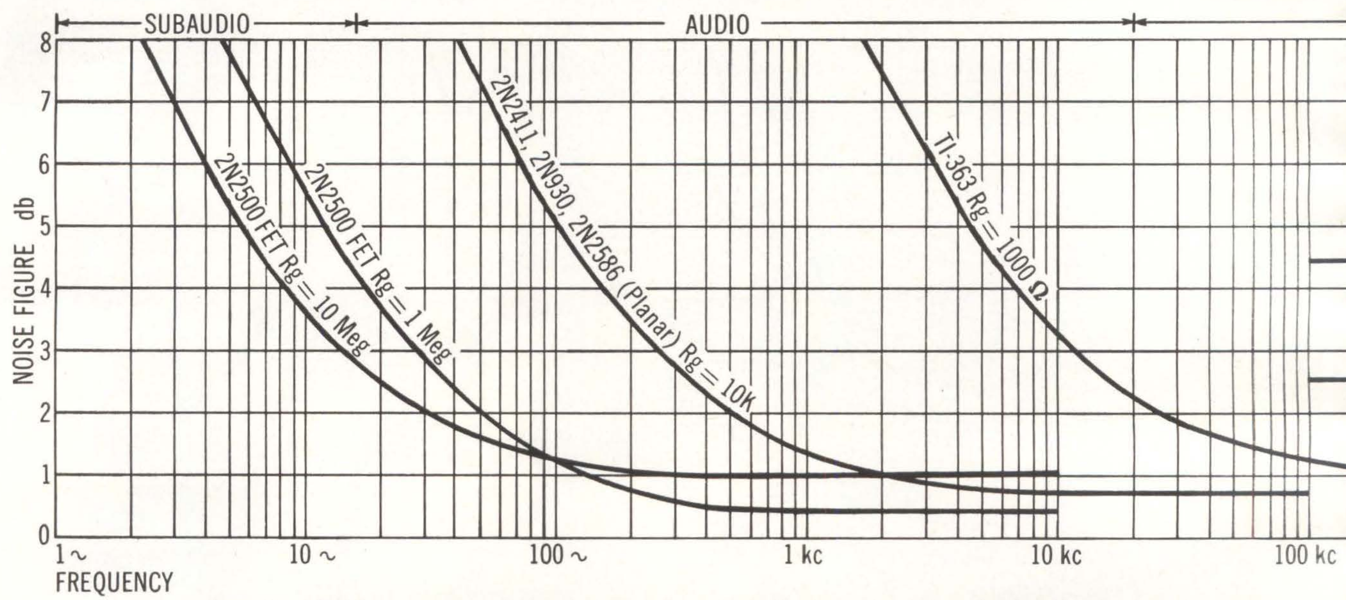
10 DECADES OF LOW-NOISE DEVICES

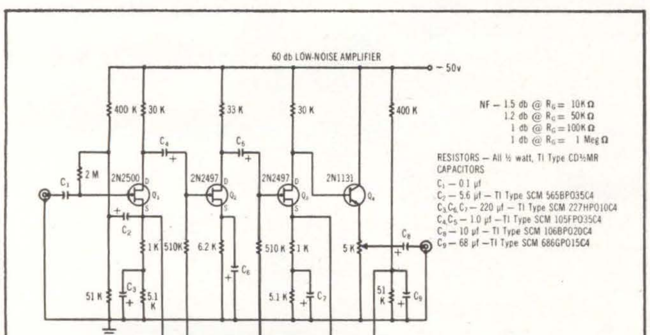


The units plotted here are representative of a broad range of over 100 low- noise devices TI offers for your low-noise applications.

Low-noise devices for your

SUBAUDIO CIRCUITS

Texas Instruments 2N2497-2500 series field-effect transistors give the design engineer extremely low-noise characteristics — as low as 5 db at 10 cycles. They are ideal for such low-frequency equipment as null-detection apparatus, medical research equipment, oscillographic and magnetic tape recorders, oscilloscopes and all types of low-level transducers. ■ The circuit below illustrates how Texas Instruments 2N2500 silicon field-effect transistors are used to achieve low-noise, low-frequency operation.

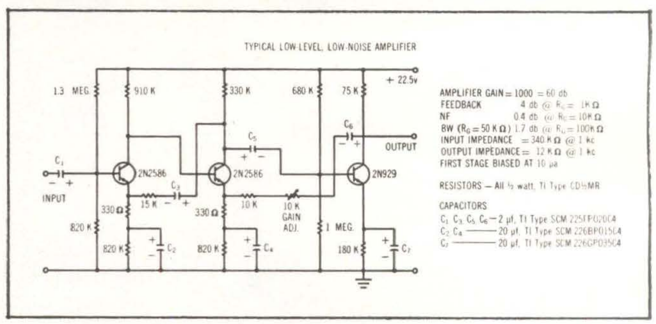


This circuit gives you a maximum voltage gain of 60 db ±0.5 db from –55°C to 125°C with built-in gain adjustment. You also get good low-frequency response and stable circuit operation. ■ Write for your technical information file on low-noise TI devices for your subaudio applications.

Low-noise devices for your

AUDIO CIRCUITS

Now you can design the low-level, high-gain amplifier shown below with typical noise figure as low as 1 db. Advanced low-level planar technology of Texas Instruments 2N929 and 2N2586 transistors makes possible high gain at low current levels, plus the extremely low leakage currents necessary for true low-noise performance.



For high-impedance transducer applications, TI 2N930 and 2N2586 devices permit typical 1 db noise figure at emitter currents below 1 microampere, and generator resistances over 1 megohm. These special characteristics allow direct coupling of low-level, high-impedance sources... advantages previously available only with vacuum tubes and field-effect transistors. High gain at low levels plus very thin regions in these units combine to offer low power consumption and high radiation resistance to make the 2N930 and 2N2586 ideal for space applications. ■ A technical information file on almost 50 TI low-noise devices for audio circuits is yours upon request.

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

SEMICONDUCTOR-COMPONENTS DIVISION

WASHINGTON OUTLOOK

SUPERSONIC AIRLINER NEEDS AUTOMATIC LANDING SYSTEM

DEVELOPMENT of a fully automatic landing system is a prerequisite to U.S. entry into the supersonic airliner field, it was brought out in an advisory group report to Federal Aviation Administrator Najeeb E. Halaby. The report urges the U.S. to enter the supersonic airliner race quickly. The government would recoup the estimated $1 billion development costs through royalty charges to the airlines.

An administration go-ahead is expected this summer, although Halaby asked the advisors to provide more details. An unresolved problem is the need for fully automatic landing at zero-zero weather conditions. The planes would be so fast (mach 2.3 to 3.5) that one leaving New York would need simultaneous landing clearance in Los Angeles, and weather must not prevent its landing.

$150 MILLION IN FAA BUDGET FOR ELECTRONICS

FEDERAL AVIATION AGENCY is requesting $99.8 million for fiscal 1964 to buy and install new air navigation and air traffic management equipment. This includes radars, radar beacons, towers, approach lights and radio range transmitters. The current appropriation for this program is $113 million. FAA is also requesting $50 million in new R&D funds, including $37.6 million for work on traffic control and navigation.

A-M STATIONS FACE NEW CURBS

TOUGHER ENGINEERING and financial standards are on the way to curb the proliferation of uneconomic a-m radio stations. The National Association of Broadcasters and the Federal Communications Commission are concerned about the problem of more stations getting a smaller share of some $400 million in radio revenue. In 1961, a third of the licensees reported losses.

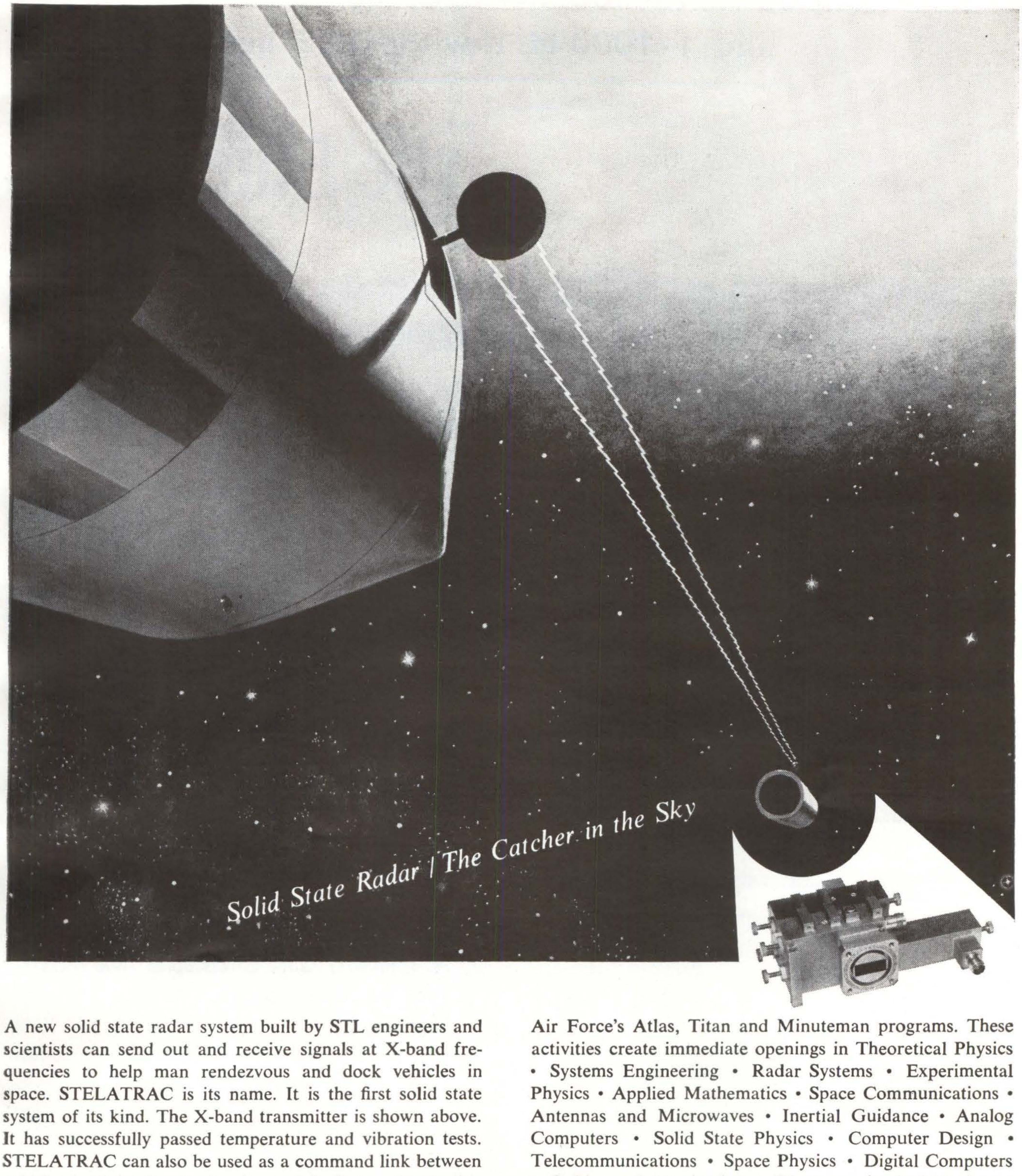
NAB wants FCC to raise financial standards and prod weak stations to merge. In addition, industry wants tighter engineering standards, including higher power to improve service, instead of new stations, and an end to the 10-percent rule that entitles an applicant to a station license if no more than 10 percent of his projected signal contour will receive objectional interference.

SATELLITE COMPANY NEARS INCORPORATION

SPACE COMMUNICATIONS CORPORATION is expected to file articles of incorporation by February 1. The 13-man team of incorporators, appointed last October, are ready to present their final draft of the articles to President Kennedy for his approval. The communications industry and government agencies were briefed last week. After the filing, the incorporators will become temporary board members until stocks are sold and the stockholders elect a permanent board of directors. This may take six months to a year.

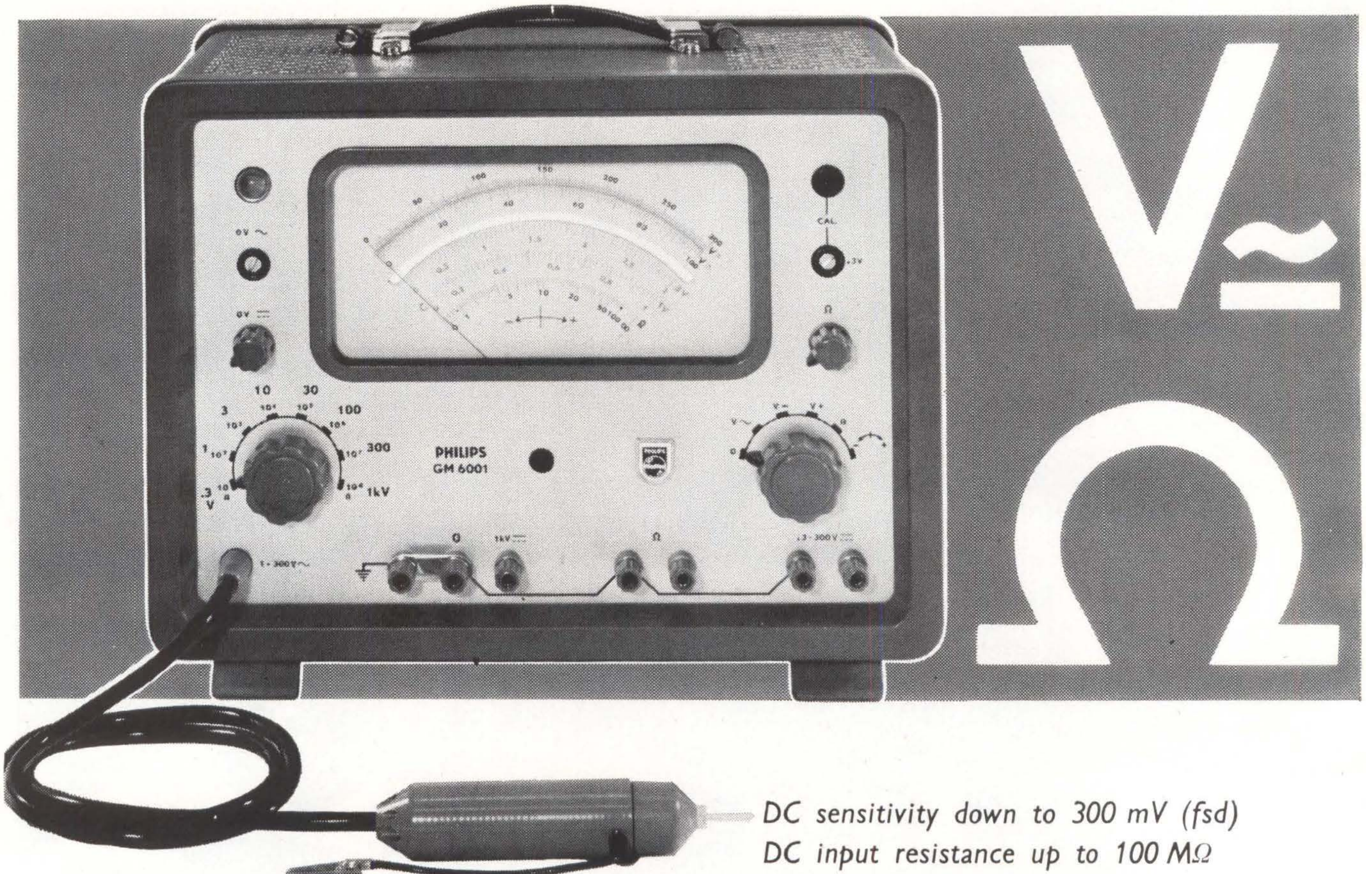
TAX COLLECTOR EXPLAINS CREDIT

GOVERNMENT TAX EXPERTS are going on the road to sell industry on plant modernization. In the first session next month in Philadelphia, Stanley S. Surrey, Assistant Secretary of the Treasury, and Internal Revenue Service Commissioner Mortimer Caplin, will try to combat skepticism and confusion about the investment tax credit voted last year by Congress. Commerce Department's Business and Defense Services Administration and local industry are sponsoring the meeting.


Solid State Radar / The Catcher in the Sky

measuring down to 300 mV DC, up to 1000 Mc/s AC,
and 1-1000 MΩ with ONE instrument only,

the Electronic



DC sensitivity down to 300 mV (fsd)
DC input resistance up to 100 MΩ
Floating input
AC frequency range 25 c/s up to 1000 Mc/s
Very low input capacity
High accuracy
Resistance range 10 Ω - 100 MΩ (centre scale values)
Stabilized HT and heating current

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Volt-ohm-meter, type GM 6001

Specification

DC Voltages

Measuring ranges	: 300 mV (f.s.d.) - 1000 V
	: by means of EHT probe up to 30 kV
Accuracy	: 2.5 %
Input impedance	: range 300 mV: 10 MΩ
	range 1 V: 30 MΩ
	other ranges: 100 MΩ

Floating input
Special centre-zero facility

AC Voltages

Measuring ranges	: 1 V (f.s.d.) - 300 V
Frequency range	: 25 c/s - 1000 Mc/s
Accuracy	: 3 %
Input impedance	: 3 MΩ at 1 Mc/s
	0.4 MΩ at 10 Mc/s
	0.07 MΩ at 40 Mc/s
Input capacity	: 3.5 pF

Resistances

Measuring range	: 10Ω - 100 MΩ *(centre scale values)*
Accuracy	: 8 %
	range 100 MΩ : 10 %

Mains supply	**: 110 ... 245 V, 40-100 c/s**

Optional accessories

EHT probe GM 6071	
Attenuation	: 100 x
Maximum input voltage	**: 30 kV**
Coaxial T-piece PM 9250 for measurements on coaxial lines	
Impedance	: 50Ω
Frequency range	: 0.1 ... 1000 Mc/s
V.S.W.R.	: 1.1 up to 800 Mc/s
	1.2 for 800 ... 1000 Mc/s

Internal calibration

It should be noted that all Philips electronic voltmeters contain calibration standards which enable the user easily and rapidly to check, and, if necessary, to re-calibrate his voltmeter at any time without the use of additional instruments.

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

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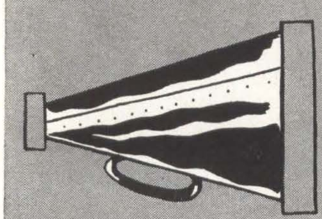
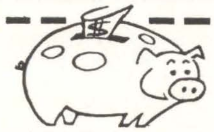


ANNOUNCING FOR 1963
a tremendous
electronics BUYERS' GUIDE Issue



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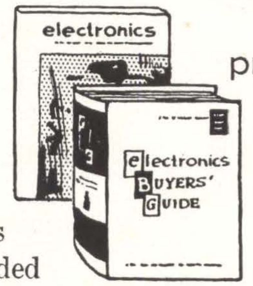

electronics every Friday—to create preference for your products...

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

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

CATALOG ADVERTISING RATES PER PAGE:

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Space Used	Rates
1 page	$900
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6-7 pages	630 per page
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20-23 pages	465 per page
24 or more	440 per page

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6-7 pages	585.90
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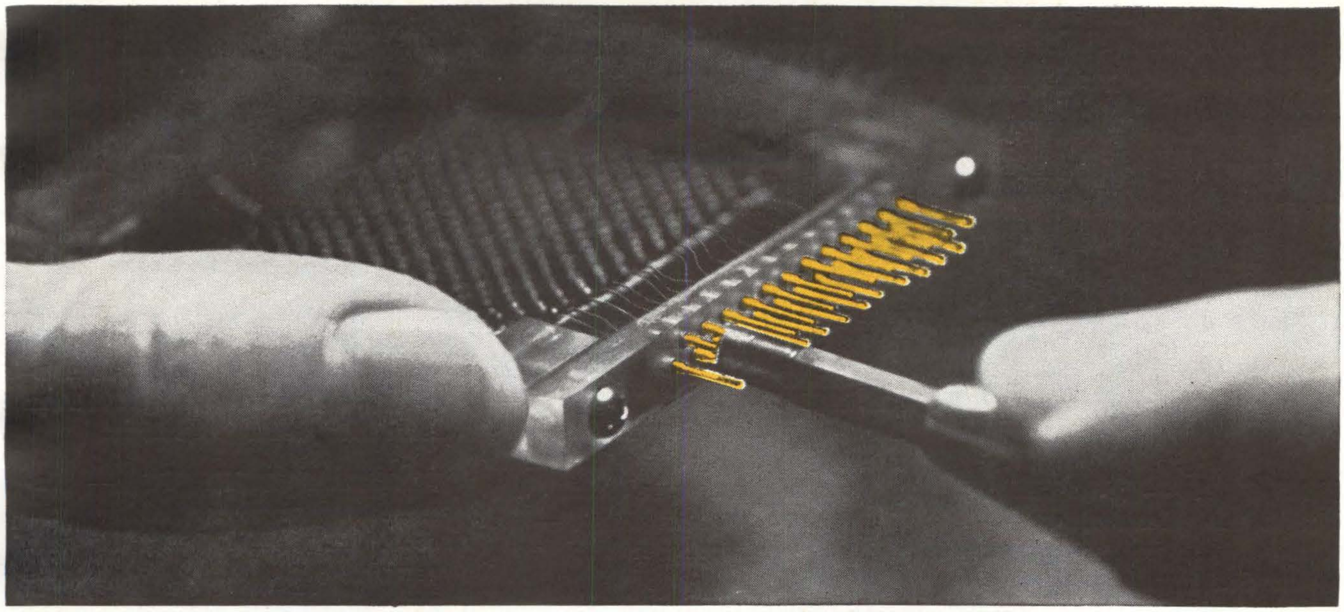
12-15 pages	$506.85
16-19 pages	460.15
20-23 pages	433.45
24 or more	409.20

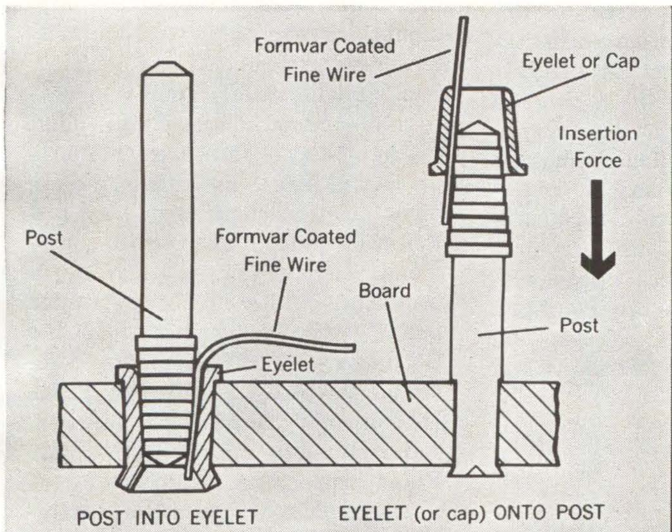
"EARLY BIRD" Closing Dates (For Discounts)

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

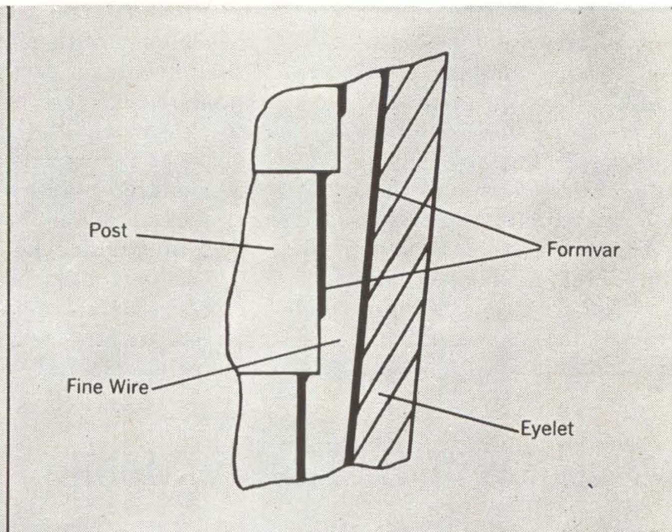
For Complete Information, Contact Local Sales Offices Listed on the Last Page of This Issue



Fine wire finesse!



APPLICATION OF FINE-Y-R TERMINATION



CROSS SECTION OF POST IN EYELET

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

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

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

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

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CIRCLE 17 ON READER SERVICE CARD

Military Electronics Will Level Off in Fiscal 1964

But slack will be taken up by a big rise in space budget

WASHINGTON — More than $9 billlion for new electronics production, research, development, test and evalution spending is included in the defense and space budgets for fiscal year 1964 that the Administration submitted to Congress last week.

While the total military budget sets a new peacetime record (see table), there will be a virtual leveling-off in new military electronics contracts. The estimate for such contracts is about $6.6 billion.

Space spending by all government agencies adds up to about $3.1 billion for satellite electronics and supporting electronics equipment. Of this total, about $800 million is for military space electronics and the remainder—about $2.3 billion—is for nonmilitary projects. NASA is asking for large increases in its major programs (see table).

MILITARY ELECTRONICS — Total new orders for military electronics production are estimated at about $4.4 billion in fiscal year 1964, starting next July 1—less than $100 million over this year's rate.

Electronic contracts for Research, Development, Test, and Evaluation (RDT&E) will amount to some $2.2 billion for the new year, a slight boost over this year.

These figures are based on unofficial but authoritative estimates that about 25 percent of aircraft procurement (see table) is devoted to electronics, that electronics' share of the missile dollar amounts to about 35 percent, and that electronics accounts for about 30 percent of military RDT&E.

The only electronics figure specifically identified in the Pentagon budget covers what officials call "pure electronics"—electronics and communications equipment not associated with aircraft and missile systems. Total orders in this category will increase to $1.5 billion from this year's $1.4 billion.

PROGRAM BUILDUPS — Increased Army contracting will cover FM series vehicular and portable communications sets; improved airborne terrain-surveillance and reconnaissance equipment and air-to-ground equipment to increase the air mobility of tactical forces; global strategic command and control systems equipment; cryptographic and countermeasures equipment and devices; and "modification improvements" for fire-control and direction radar.

The Navy's procurement program will stress antisubmarine devices and information display and tactical command and control equipment. The Navy will also begin production of the Walleye "guided bomb"; accelerate output of the Goodyear Aircraft-Kearfott Subroc antisubmarine missile; Texas Instruments' Shrike air-launched, radar-homing missile (the Air Force will make its first buy of Shrike next year); and the Martin-Maxson Bullpup air-to-surface missile.

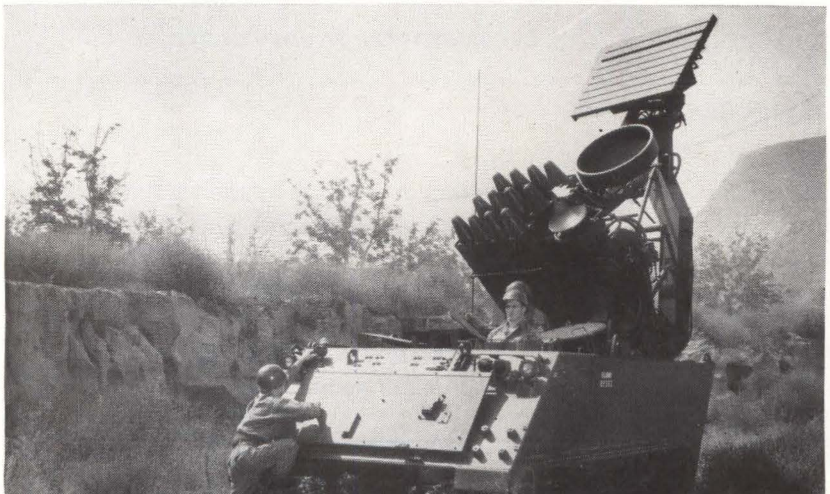
CUTBACKS — Reduction in Air Force electronics procurement reflects scheduled completion of installation of the Bmews system and the SAC control system.

In the RDT&D field, the Air Force will continue development of "reconnaissance strike components" for the RS-70 and "for possible application to various aircraft." But Defense Secretary McNamara is sticking by his controversial decision not to begin production of the aircraft.

Similarly, production of the Army's Nike Zeus anti-ICBM system is once again turned down.

NEW ANTI-ICBM'S—The budget, however, earmarks over $325 mil-

Mauler Will Be Highly Mobile



RADAR-GUIDED *Mauler missiles will be used by Army to protect forward battle positions against bombing and strafing aircraft and short-range ballistic missiles and rockets. Maulers will be fired from moving vehicles. Photo shows engineering mockup of system, being developed by General Dynamics/Pomona; $16.6 million was just added to R & D contract.*

DEFENSE BUDGETS, FISCAL YEARS 1963 AND 1964

	FY 1963	FY 1964
	(Billions of Dollars)	
Total Defense Budget		
New Appropriations	50	52.2
Expenditures	48.3	51
Total Military Procurement		
New Appropriations	16.6	16.7
Expenditures (essentially deliveries)	15.5	16.3
New Contracts	17	17.3
Aircraft	6.2	6.2
Missiles	4	3.9
Ships	2.7	2.5
Other Procurement	4.1	4.6
Army Electronics & Communications	0.3156	0.365
Air Force Electronics & Communications	0.6268	0.564
Navy Electronics & Communications	0.368	0.556
Total Research, Development, Test & Evaluation		
New Appropriations	7	7.3
Expenditures	6.6	7.1
New Contracts	7.2	7.4

NASA'S PROPOSED BUDGET FOR SPACE PROGRAMS

	FY 1963	FY 1964
	(Millions of Dollars)	
Total NASA Budget		
New Appropriations	3,673	5,712
Expenditures	2,358	4,154
Major Programs		
Manned Space Flight	1,707	3,193
Meteorology	64.3	73.1
Communications	49	55.8
Earth Satellites	174.2	232.6
Lunar & Planetary Exploration	226.4	331.3
Launch Vehicle Development (other than manned flight)	121.5	149.5
Space Vehicle Systems	89.7	111.4
Electronic Systems	44.9	59.3
Propulsion and Space Power	193.7	268.8
Aircraft Technology	44	45.1
Tracking & Data Acquisition	159.8	261.6
Other Research Programs	75.8	129.8
Construction of Facilities	737.4	800
Total	3,673	5,712

lion to the Army for development of an improved, redesigned Zeus system— dubbed "Nike X" and including the Sprint project—and more than $100 million for other anti-ICBM research efforts. Test firings of Nike Zeus will continue.

AIR FORCE R&D—Work on a ballistic missile reentry system to improve penetration of enemy defense systems is included in Air Force R&D. Space R&D will be increased slightly with work devoted to the Dyna-Soar; navigation satellites; a communications satellite system; satellite tracking, identification, and intercept systems; and guidance and navigation components.

Defense Department communications satellite development will concentrate on a low-altitude system, while NASA stresses work on a high-altitude synchronous system.

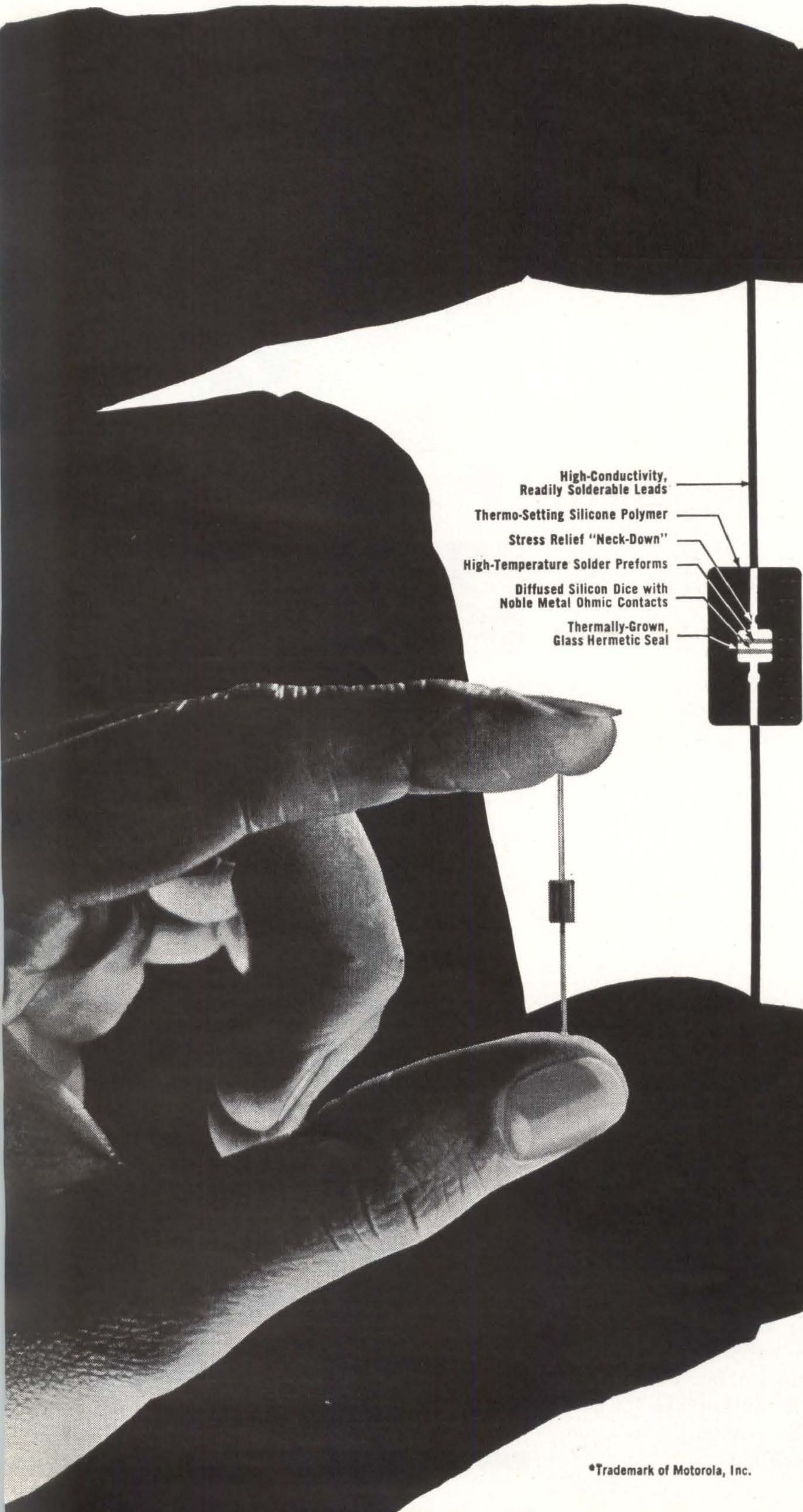
SPACE BUDGET—NASA is stepping up development of the Nimbus meteorological satellite to $43.8 million in fiscal 1964, compared to $30.3 million this year. Part of the increase stems from problems in perfecting the satellite so that it will remain earth-oriented. Nimbus's cameras are to point toward the earth constantly. The Tiros weather satellites point toward earth only part of the time.

The space agency is budgeting $55.8 million for communication satellites. Of this, $40 million is earmarked for developing an advanced Syncom satellite to be placed in a synchronous orbit. From now on, NASA will concentrate its satellite communications efforts on synchronous orbits.

THE INSIDE STORY... on an important advance in zener diodes

The technique of integrally sealing the surface of silicon semiconductor junctions—so successfully applied in the Motorola Star Planar Transistor—has now been modified to meet the requirements of a new type of zener diode.

In the new Motorola zener diode, the silicon surface is oxidized at a relative low temperature to form an integral layer of protective glass that is essentially impervious to the penetration of moisture and other contaminants. This unique glass-passivating technique was developed as part of a military contract program sponsored by the Manufacturing Technology Laboratory of the Air Force Aeronautical Systems Division at Wright-Patterson Air Force Base. The resulting glass surface, whose thickness is measured in Angstrom units, is as impervious to moisture penetration as conventional hermetic sealed packages, and is conservatively 10,000 times less permeable than typical "paint-on" and epoxy coatings.



SURFACE PASSIVATION TEST RESULTS—These surface passivated dice, with leads attached and no further protection, passed all standard mil high temperature-humidity storage.

With the hermetic seal now an integral part of the dice, the main requirement of a package is provision for the necessary mechanical strength without degradation.

Various epoxy plastics were investigated but found lacking in both mechanical and dielectric strength at temperatures above 150°C.

Turning to silicone polymers, which are known for their high temperature capabilities, Motorola scientists worked with the supplier — Dow Corning — through several changes in the composition of the silicone plastic, finally developing one compound that met all requirements. Devices of this type have passed 1,000 hour operating tests at 200°C and storage in air at 400°C . . . far beyond the limits of conventional encapsulated devices.

Of special interest in military applications, is the fact that, unlike most epoxy plastics, the Motorola silicone zener diode will not "flame." This can be demonstrated by holding a match (700-800°C) to the package. The Motorola silicone zener not only refuses to ignite, but its reverse electrical characteristics will return to normal after the flame is removed.

NEW PACKAGING PROCESS — Most epoxy packages are merely cast. Consequently, they contain voids that permit the penetration and collection of moisture. With Motorola's special, high-pressure molding process, the silicone is void free, eliminating a source of moisture and corona problems.

The final product, which we call the "SURMETIC"* zener diode, has been subjected to all standard military tests. It not only passed these, but also met such special tests as: 20,000 g acceleration; 1,500 g shock; 175°C continuous power operation and high temperature lead-pull tests.

This is the first zener diode available with a true inorganic glass surface passivation, a silicone plastic package, and conservative ¾ watt and 175°C ratings in a package that is no larger in volume than the conventional 400 mw glass package. It is being introduced in the more popular 11 to 51 volts range. The price for this ¾ watt unit is competitive with 250 and 400 mw units. We invite you to investigate the capabilities of this new development for your applications.

For more information write or call your local Motorola Semiconductor representative.

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★ **ACCURACY**
±0.01%
0-500V DC

★ **DURABILITY**

★ **LOW COST**
$895.00 FOB SEATTLE

FLUKE MODEL 821A Now—for the first time—it is possible to obtain ±0.01% accuracy with a differential voltmeter over a 0-500V DC range *regardless of source impedance!* Built-in rugged construction, plus the use of highest quality components and latest manufacturing techniques guarantee long, trouble-free operation. Through simplified circuitry and conservative design, factory selection of components is virtually eliminated insuring ease-of-maintenance ... minimum down-time. Fluke instruments cover many applications such as: calibrating, testing, and stability measurements of regulated power supplies, DC voltmeter calibration, AC voltmeter calibration and precise AC voltage or current measurements when used with an AC/DC transfer standard. The John Fluke Mfg. Co. is the most experienced manufacturer of differential voltmeters—with over 18,000 in use today! Buy with confidence from the company that developed the *differential voltmeter!*

PARTIAL SPECIFICATIONS:

ABSOLUTE ACCURACY: ±0.01% of input voltage from 0.5 to 500V. ±0.01% of input voltage plus 10 microvolts below 0.5V.

INPUT RESISTANCE: Infinite at null from 0 to 500V

METER RESOLUTION: 5uv maximum; 1 MV full scale.

CALIBRATION: 500V working reference supply calibrated against built-in standard cell.

STANDARD CELL STABILITY: 0.003% per year.

INPUT POWER: 115/230V AC ±10%, 50-400 cps, 60 watts.

FEATURES:

• Infinite resistance at null over entire 0-500V range • Polarity switch • Taut-band suspension meter • Standard cell reference • Recorder output • In line readout with automatic lighted decimal • No zero controls

The complete FLUKE line of differential voltmeters offers a variety of test/measuring instruments to meet every application at minimum cost. Ask for a demonstration or write for detailed information.

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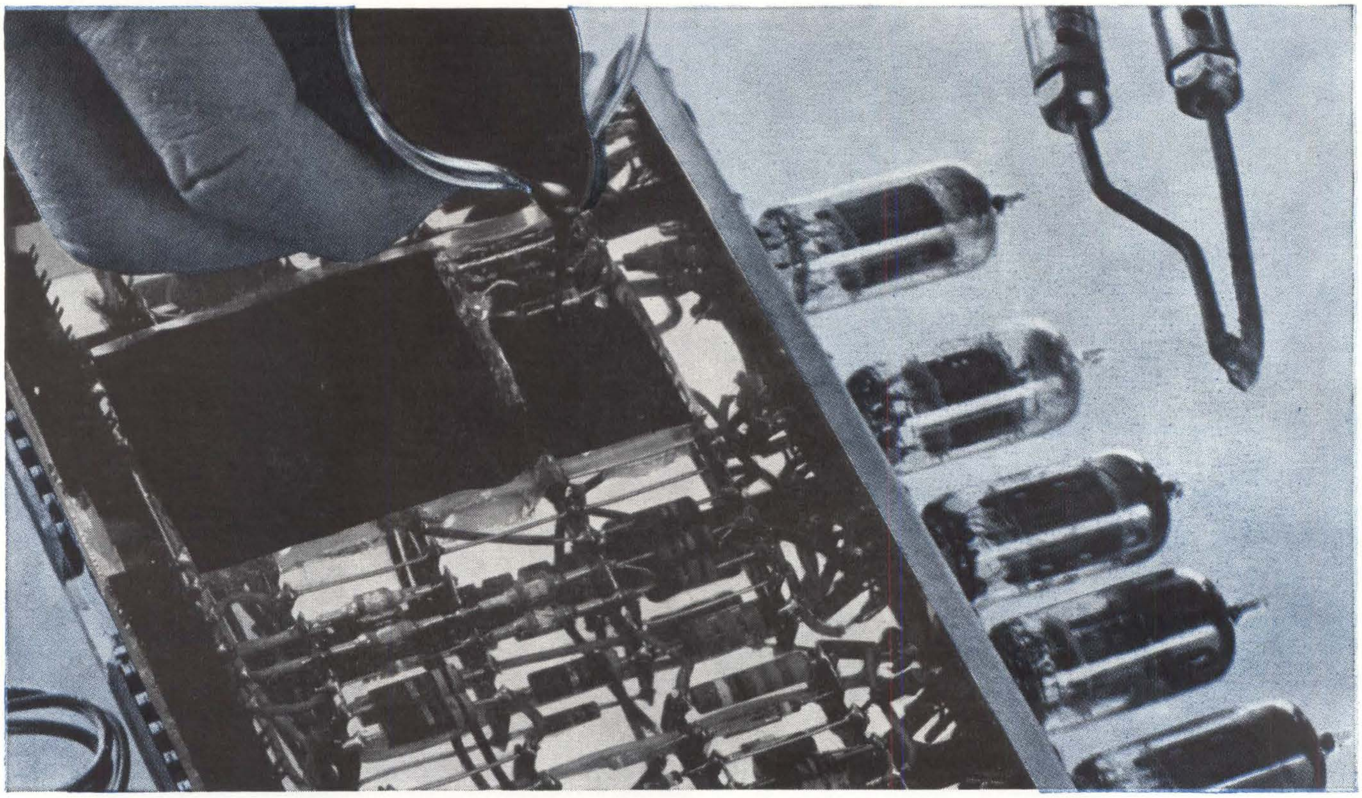
CIRCLE 21 ON READER SERVICE CARD

SILICONE NEWS from Dow Corning

To meet tough-spot specs



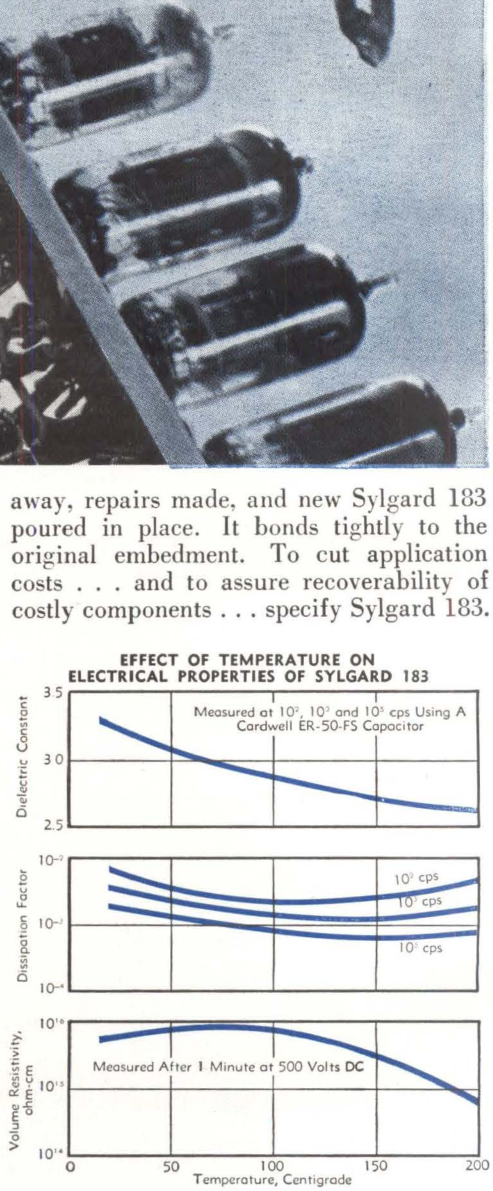
For resilient protection, specify easy-processing Sylgard® 183

Specify Sylgard 183, the new opaque solventless silicone resin, for embedding, potting, or encapsulating circuits or impregnating components. It is resilient . . . has excellent dielectric properties, heat stability and mechanical strength.

Processing is simple with Sylgard 183. Blend it with a curing agent and pour it in place . . . it cures without exothermic heat to a tough, flexible, impervious jacket. Because of its low viscosity . . . about the same as No. 40 engine oil . . . Sylgard 183 flows rapidly around the most intricate shapes. It cures in sections of unlimited thickness, and even in completely sealed assemblies. Curing time can be varied from four hours at 65 C (150 F) to only 15 minutes at 150 C (300 F). After curing, the material can be used immediately at temperatures from −65 to 250 C (−85 to 500 F). No post cure is required.

Protection is assured because fully cured Sylgard 183 withstands heat, moisture, shock, vibration, ozone, voltage stress and thermal cycling over a wide range of temperature, frequency and humidity. This new Dow Corning resin is compatible with metals, plastics, glass, asbestos, ceramics, natural and synthetic fibers, and also with Dow Corning's transparent solventless casting resin, Sylgard 182, as shown above. When sealed components must be repaired or replaced, Sylgard 183 can be cut away, repairs made, and new Sylgard 183 poured in place. It bonds tightly to the original embedment. To cut application costs . . . and to assure recoverability of costly components . . . specify Sylgard 183.

EFFECT OF TEMPERATURE ON ELECTRICAL PROPERTIES OF SYLGARD 183



CIRCLE 289 ON READER SERVICE CARD

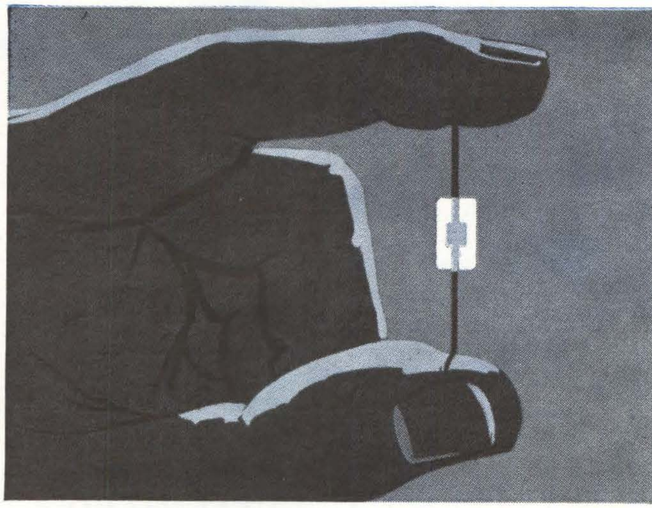
Dow Corning is your best source for a broad line of silicone fluids, gels, elastomers and rigid forms for potting, filling, embedding and encapsulating

first in silicones

Dow Corning

-specify these silicones

To package silicon diodes

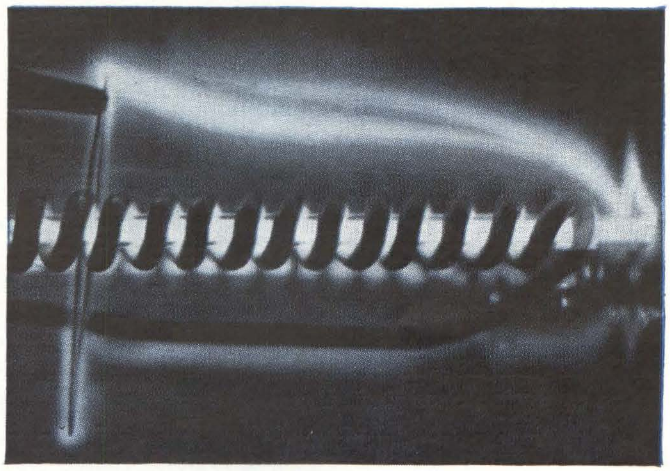


Mechanical strength and good dielectric properties at temperatures to 175 C minimum were requirements for the protective package needed by Motorola Semiconductor Products, Inc., for their new glass surface-passivated "Surmetic"* zener diode. The material specified is a Dow Corning Molding Compound developed for this application. It molds easily and quickly at temperatures and pressures that will not damage the semiconductor junctions . . . produces a void-free package that eliminates moisture and corona problems . . . doesn't soften when device leads are soldered . . . has withstood storage in air at 400 C and operating tests of 1000 hours at 200 C . . . is a big contributing factor to the high 175 C operating junction temperature rating of these Motorola "Surmetic" devices. A plus in military application: the Dow Corning Silicone Molding Compound will not flame.

* "Surmetic" — a trademark of Motorola, Inc.

CIRCLE 290 ON READER SERVICE CARD

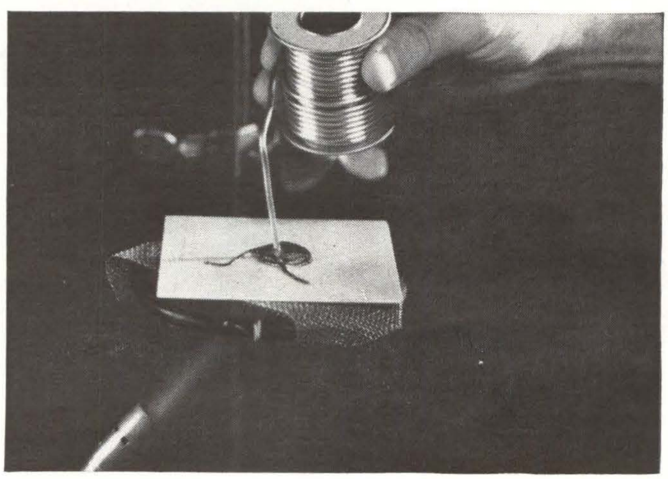
Silastic spurns corona



Corona discharge can cause rapid insulation failure, but not when wire and cable are insulated with Silastic®, the Dow Corning silicone rubber. Samples subjected to over 12,000 hours of this test, which creates a high concentration of ozone, show no signs of cracking or checking when flexed. Other important Silastic properties: flexibility and stability from −130 to 500 F; consistently high dielectric strength under adverse conditions; inertness to oxygen, many chemicals; resistant to water, vapor, steam, weathering; minimum deterioration due to age, thermal cycling, or exposure to radiation.

CIRCLE 291 ON READER SERVICE CARD

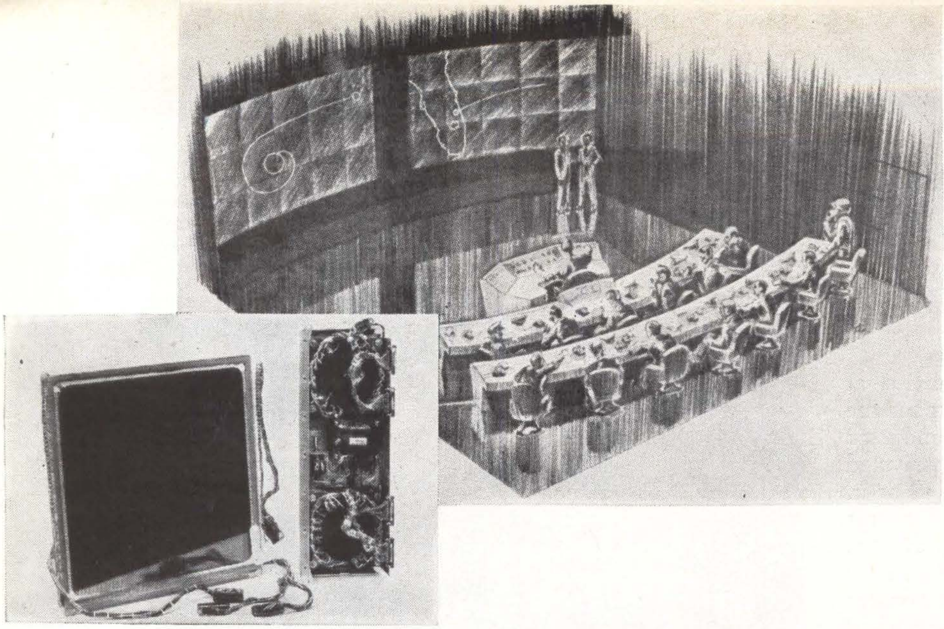
Laminates resist solder heat



The heat needed to melt solder won't loosen terminals from silicone-glass laminates, even where complex wiring requires repeated soldering in small, confined areas. Long-term heat resistance is also exceptional . . . up to 250 C continuous for years . . . much higher for short periods. In addition, silicone-glass laminates retain excellent dielectric properties despite moisture, storage, environmental aging, changing ambients, and shock. They offer low loss factor, low moisture absorption, good resistance to arcing, corona, corrosion. Weight-strength ratios are high, and machinability, even in thin sections, is exceptional.

CIRCLE 292 ON READER SERVICE CARD

For detailed data on these silicones, contact
Dow Corning Corporation, Dept. 3913, Midland, Michigan



DISPLAY PANEL *prototype (photo) developed by Lear Siegler can be built up into wall-sized position maps as indicated in sketch*

LARGE DISPLAYS:

Military Market Now, Civilian Next

Here are three ways data can be quickly shown on a big wall

By HAROLD C. HOOD
Pacific Coast Editor

LOS ANGELES—Three totally different approaches to the problem of displaying increasingly complex military intelligence will be aired next week at the IRE Winter Convention on Military Electronics.

Systems described will include:

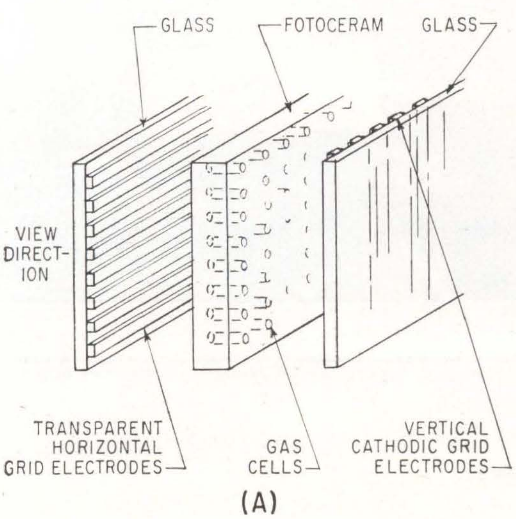
- Flat-sandwich, gas-discharge panel, developed by Lear Siegler
- Electroluminescent display with an element density of 256 per square inch, from Westinghouse Electric
- Multicolor, back-lighted system using magnetically operated shutters, reported by Electro Nuclear Systems.

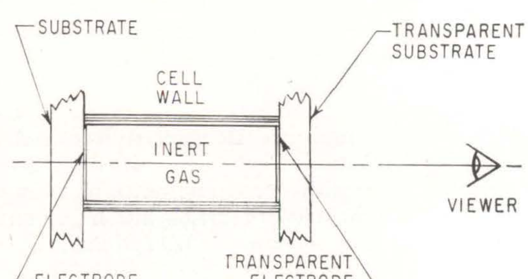
All three developers believe, as do other companies in the field such as General Electric and General Telephone, that large military displays will soon be a multimillion-dollar business, and that many nonmilitary markets, educational and business displays, for example, will quickly develop.

All feel that such displays will facilitate decision-making which cannot be performed by computers. Picture-on-the-wall tv is also a possibility.

GAS-DISCHARGE TUBE — Lear Siegler, which adopted the gas-discharge-tube principle to maximize brilliance for a cockpit display developed for the Navy, sandwiches a 0.06-inch layer of photoceramic material (Fotoceram) between two plates of $\frac{1}{4}$-inch soft glass in one of its prototype displays.

Cathode grids (see diagram) consist of evaporated Nichrome plus copper with an electroplated topping of Permalloy. Anode strips, deposited on the glass plate facing





ELEMENTS *of Lear Siegler display consist of glass-ceramic sandwiches (A). Each hole in ceramic is a gas cell (B) fired through a geometric grid of conductors* the viewer, are of transparent indium oxide. At each intersection of anode and cathode strips is a 0.05-inch-diameter cylindrical hole etched in the ceramic and filled with neon.

The 10-inch-square display consists essentially of 10,000 tiny neon gas cells which are individually lighted when a current is impressed across their X and Y electrodes.

Contact with the system's electronics is made through conducting strips led to the edge of display plates. Typical cells have a 250-v firing voltage and 125-v extinction voltage. A holding voltage of 200-v will keep cells ON or OFF, providing memory capability.

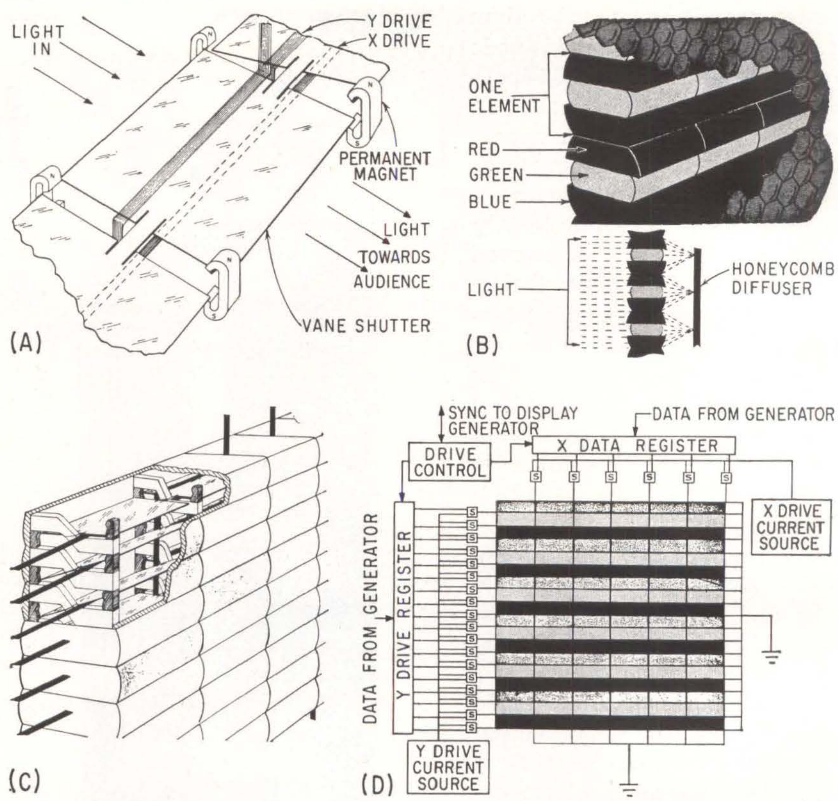
The prototype's spot brightness is 300 foot lamberts. Cell rise time is 50 μs and decay time is 80 μs. Predicted lifetime is over 2,000 hours.

Display components can be made inexpensively with mass-production techniques, the company says. Densities of 2,500 cells an inch are possible with present methods. A random-hole approach might provide up to 250,000 cells per square inch.

One of the more promising solutions to the expense of having a transistor switching circuit for each cell, according to David Moore, of Lear Siegler, is to terminate the anode and cathode strips in two cathode-ray switching tubes. The beam could be swept across the desired contacts.

ELECTROLUMINESCENT—Westinghouse thinks 10 to 12-foot-lamberts brightness per element is sufficient for most military displays. It uses a basic 4-inch-square building block of 4,096 elements. Each module is made up of 32 sandwich structures containing bridge capacitors, indirect storage capacitors, suppressor resistors and ionic switches. Electroluminescent screen layers are sprayed on the module's front surface and overlaid with a transparent deposition of gold for the common electrode.

Two ferroelectric capacitors associated with each electroluminescent phosphor cell store the d-c potential for control of light output. Control is by a nonlinear ferroelectric bridge and depends for operation upon its nonlinear variation of capacitance with voltage. When an



MULTICOLOR DISPLAY *is achieved by Electro Nuclear Systems with back-lighting and magnetically operated shutters (A). Other sketches are lens arrangements (B), segment of a panel module (C) and drive and control hookup (D)*

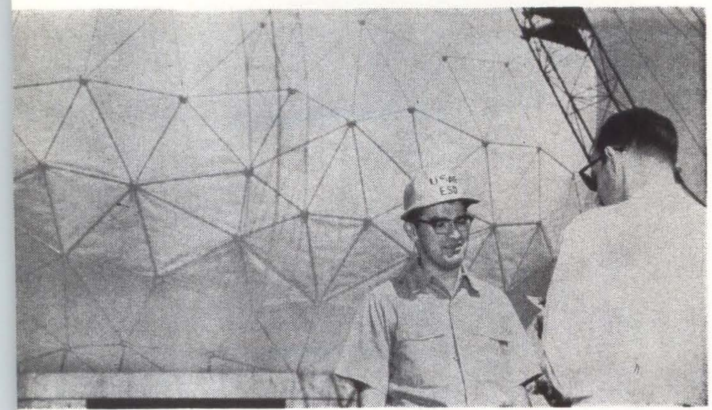
initial charge of 200 v on the indirect storage capacitor drops to zero, the bridge becomes unbalanced and the a-c voltage across the electroluminescent capacitor results in light output.

Palladium ionic switches, or spark gaps, provide information storage and element isolation in the matrix selector sytem. These are fabricated in steatite strips of 16 each, with electrode gaps of 6 to 8 microns. They are fired by 320 to 360 v, well above the amplifier logic level of 200 v. Surrounded by an argon-nitrogen-oxygen environment, these switches last well over 1,000 hours.

Peripheral circuitry consists of X-column and Y-row drivers. The X amplifiers use *pnpn* switches that will block 200 v in the OFF position and can be triggered to ON by a relatively low-power pulse. Two of the same type of switches are used back-to-back in the Y-row commutator that controls passage of the ionic switch firing voltage.

MULTICOLOR DISPLAY—Brilliance of its display, reports Electro Nuclear Systems, is unlimited and depends upon the number and intensity of conventional fluorescent lamps used. Each of the ¼-inch-square elements has a seven-color capability, transmitting any one or combination of three primary colors introduced by the plastic lenses (see diagram above). Each has three individually controlled magnetic vanes.

Vane operating speed is about 1 ms. Microsecond response is expected in future models. Small permanent magnets lock the vanes in either the open or closed position. Each X and Y-drive line carries slightly more than half the current required to force a vane away from its detent, so simultaneous pulses through both wires are needed to change vane position. The panel can be driven by high current switching devices such as transistors, SCR's or relays as needed for each X and Y-drive line. The entire system—display generator, data distribution network and display panel—is reportedly compatible with existing command and control information processing systems and can accept information from such sources as computers, communication circuits, digital stores and tv systems.



PLASTIC TRIANGLES, *measuring up to 15 feet on a side and installed in a random pattern to avoid interference, make up 134-foot-high radome for Haystack facility. The 120-foot antenna is to be completed late this year*

Air Force Upgrades Space Research Microwave Center

Monopulse radar and "baby Arecibo" are added at Millstone

By THOMAS MAGUIRE
New England Editor

BOSTON—An S-band monopulse radar antenna system is the latest in a series of Air Force-MIT Lincoln Laboratory projects that have made the Millstone-Haystack complex in northeastern Massachusetts a multi-million-dollar center of radar and communications research.

The S-band parabola is the prototype of an antenna which will be built at Arbuckle Neck, Va., a Lincoln Lab site for reentry studies.

The military research center, carved out of wooded areas in Westford and Tyngsboro, Mass., just south of the New Hampshire line, also includes the Millstone Hill radar upgraded this year, a 220-foot ground-mounted paraboloid for ionospheric backscatter studies at uhf, the 60-foot parabola for Project West Ford, and the Project Haystack 120-foot antenna facility still under construction (ELECTRONICS, p 34, May 5, 1961, and p 49, Nov. 9, 1962).

SPACE RESEARCH—The original Millstone Hill antenna system, built for missile defense research, was quickly adapted for satellite tracking when the first Sputnik went up.

Until last March, Air Force had a crew at Millstone Hill for routine satellite tracking. The station was shut down then for modifications. It is no longer used for routine satellite tracking, but its tasks in space physics research do include tracking experiments.

A Cassegrain reflector has been installed on the 84-foot dish, and a lobe-comparison tracking feed at L-band. New transmitter components include two X-780 klystrons.

Frequency was changed from 440 Mc to 1,300 Mc. With improved low-noise receivers and slightly higher peak transmitter power, this has improved net detection sensitivity by about 15 db. Thus, it can better detect echoes from Venus and brings the planet Mars within radar reach. Long signal integration may enable the system to detect Mercury.

Millstone Hill made the first radar contact with Venus in 1958. According to John V. Harrington, Radio Physics division head at Lincoln Lab, the new system should yield more reliable information on the Venusian surface and more about the planet's rotation rate. Major emphasis in recent experiments was on pulse and doppler-broadening experiments.

BABY ARECIBO — Transmitting and receiving equipment from the original system will be used with a 220-foot paraboloid mounted on the ground nearby and pointing toward its zenith.

This open-mesh antenna, a sort of junior Arecibo (ELECTRONICS, p 20, Jan. 27, 1961), permits continuation of the electron density studies of the original Millstone Hill dish. Experimenters are using noncoherent scatter techniques, observing very weak signals scattered back from the individual electrons in the ionosphere when illuminated by high powers at frequencies well above the plasma or critical fre-

Chinese Hearing Aid

STATE-OF-THE-ART *in Communist China is indicated by transistor hearing aid made by Shanghai Medical Apparatus Bureau. This is reportedly an improved model with better tone quality and more volume than earlier types* quency. Electron density and temperature profiles well into the exosphere can be obtained.

WEST FORD—At the foot of Millstone Hill is the 60-foot parabolic antenna built—along with a twin at Camp Parks, Calif.—for Project West Ford, the experimental scatter communications system that will use an orbiting belt of tuned dipoles.

In the absence of an orbiting belt, the antenna systems on the East and West coasts have been used for lunar relay, radiometric measurements of the atmosphere and satellite tracking. At both terminals, a uhf feed system was installed to permit reception of telemetry signals. Also, voice channel terminal equipment has been added. The antenna will soon be enclosed in a radome.

Coast-to-coast transmission of high-quality voice signals and high-speed data have been achieved at these terminals using the moon as a passive reflector of 8-Gc signals. Previous work on lunar scattering at this range of frequencies made it possible for Lincoln Lab researchers to use a "tailor-made" modulation technique.

Nimbus Station To Be Built in Nova Scotia

UNITED STATES and Canada will build a command and data acquisition station for the Nimbus meteorological satellite system, at Ingomish, Nova Scotia, during 1963. The station will supplement the station being completed at Fairbanks, Alaska.

Now under development by NASA and the Weather Bureau, Nimbus will be the successor to the Tiros weather satellite program. Nimbus will circle the earth in a near-polar orbit "seeing" the whole world every 24 hours. Tiros sees only about 20 percent of the earth daily. Within a few years it is expected that there will be at least one Nimbus in orbit at all times to support weather analysis.

The Ingomish station will be manned by Canadians with some U. S. personnel.

Venus: Plains and Desert?

Radar probe finds evidence of huge flats on planet

WASHINGTON — Evidence that Venus is even smoother than the moon (which in turn is smoother than the earth according to other radar experiments) has been turned up by the National Bureau of Standards' scatter radar installation at Jicamarca, Peru, reports Kenneth L. Bowles, observatory director. NBS scientists recorded echoes of 0.5-millisecond pulses from the specular point—the point on Venus nearest the earth.

Bowles believes the reflected "glints" from Venus, in the 0.5-ms and in 3-ms bursts, unlike echoes from any other planetary radar probes, are caused by the focusing of echoes by individual large flat areas hundreds or thousands of acres in extent. He also suggests that examination of the data may well end the controversy over the length of the Venusian day.

The Jicamarca installation, designed as an ionosphere depth probe is credited with first published discovery of the artificial radiation belt spawned by the high energy nuclear test in the Pacific last July. It took a stab at Venus on learning that Venus would both be closest to the earth (45 million kilometers) and directly over Jicamarca's 22-acre fixed antenna, late last year.

Other recent radar probes of Venus by Naval Research Laboratory and Jet Propulsion Laboratory scientists disclosed that Venus echoes are blank in the 1.35-cm water vapor line. Their conclusions that the planet is a windswept desert compares favorably with Jicamarca's results so far.

Thin-Film Computer

AEROSPACE *computer introduced last week by Univac is built with 1,243 integrated circuits and a 74,000-bit thin-film memory. It weighs less than 17 pounds and dissipates 53 watts*

Free World's Industrial Output Rising 5% in '63

NEW YORK — The gross national product (GNP) in the free industrial world will increase by about 5 percent in 1963. In the U.S., the gain should be nearly 3 percent.

For most industrialized nations, the outlook for 1963 is a bit less bright than it was for 1962, according to a survey compiled by the McGraw - Hill Publishing Company's Department of Economics.

Wages are going up much more in 22 of the industrialized nations than in the U.S. The gap between U.S. industrial costs and those of foreign countries is narrowing slightly. At present, the U.S. does not face a build up of the inflationary pressures that are plaguing other countries.

Estimates of the increase in percent of the gross national products in leading industrial nations include: Canada, 6 percent; Belgium 5 percent; West Germany, 8 percent; France, 6 percent; Italy, 7 percent; The Netherlands, 7 percent; United Kingdom, 5 percent; Japan, 7 percent.

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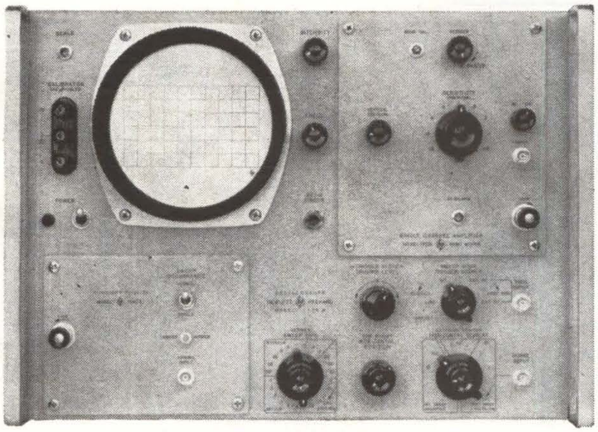

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Triggering:	Internal, from vertical input signal causing 2 mm or more vertical deflection, or from power line; external, from signal 0.25 v p-p or more
Triggering Point:	Controls allow selection of level and slope
HORIZONTAL AMPLIFIER	
Bandpass:	DC to 500 kc
Sensitivity:	2 ranges, 0.1 and 1 volts/cm; vernier provides continuous adjustment to 10 volts/cm
VERTICAL AMPLIFIER	
Rise Time:	Less than 7 nsec
GENERAL	
Power Requirements:	115 or 230 v ac ± 10%, 50 to 60 cps; maximum of 425 watts, depending on plug-ins used
Weight:	Maximum of 70 lbs., depending on plug-ins used
Price:	$1325

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SPECIFICATIONS, 175A PLUG-INS

VERTICAL PLUG-INS	
1750A 40 MC Dual Channel Amplifier:	Permits viewing of two phenomena simultaneously, bandpass dc to 40 mc, rise time 9 nsec, sensitivity 50 mv/cm to 20 v/cm; differential input for common mode rejection, $285
1751A Fast Rise Vertical Amplifier:	Rise time, < 7 nsec, dc to 50 mc; sensitivity, 50 mv/cm to 20 v/cm; vernier extends sensitivity to 50 v/cm, $160
1752A High Gain Amplifier:	Provides 5 mv/cm sensitivity dc to 18 mc with differential input for high common mode rejection, $225
HORIZONTAL PLUG-INS	
1780A Auxiliary Plug-in:	Normal and single sweep, $25
1781A Sweep Delay Generator:	For detailed examination of complex signals or pulse trains; permits viewing expanded waveform segment while still retaining presentation of earlier portions of the waveform; delay time 1 μsec to 10 sec.; delaying sweep, 2 μsec/cm to 1 sec/cm, $375
1782A Display Scanner:	Provides output to duplicate on X-Y recorder any repetitive wave appearing on scope; resolution with permanent records higher than CRT photograph, $425
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MEETINGS AHEAD

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

ELECTRICAL ENGINEERING EXPOSITION, IEEE; New York Coliseum, New York City, **Jan. 28-31.**

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

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

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

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

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

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

BIONICS SYMPOSIUM, United States Air Force; Biltmore Hotel, Dayton, Ohio, **March 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, Ohio, **April 16-17.**

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

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

ADVANCE REPORT

MEDICAL ELECTRONICS INTERNATIONAL CONFERENCE, *International Federation of Medical Electronics, University of Liege; Centre Européen des Grands Congrés, Esplanede de l'Europe, Liege, Belgium. March 1 is the deadline for submitting two copies of paper to: D. H. Pekkering, Institute of Medical Physics, 45 Da Costakade, Utrecht, The Netherlands. Main topic of the conference will be the physical transducer. Papers on devices for measuring various parameters of living systems are encouraged; examples include: plethysmograph, accelerometer, pressure transducer (e.g. electromanometer, pneumotachograph, spirometer, flow meter, tocograph, tonometer, microphone, strain gauge, ergometer, photoresistor, thermoresistor, pH electrode, microelectrode, ultrasonic detector, oximeter. Sessions on other topics will also be organized.*

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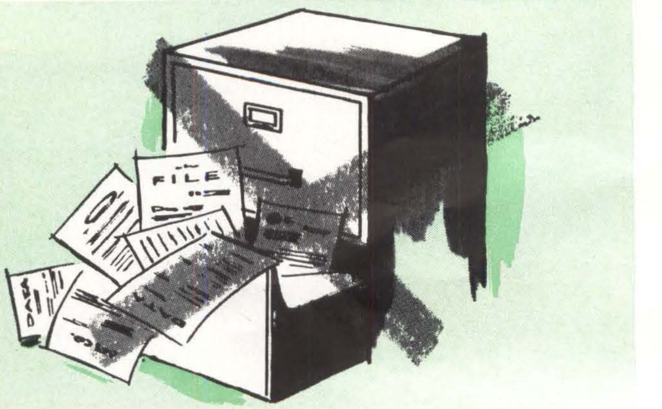

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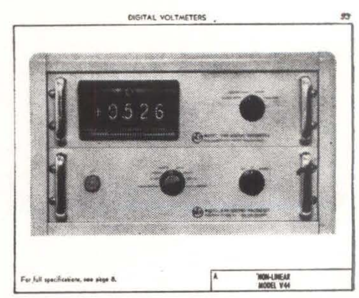

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	CUBIC (A)	V-70 j	3 manual	.001	999.9	• .01 ±1 digit	manual	d	manual	•	10M @ bal-ance	con-verter a •	• BCD or dec	•	-	-	-40db @60cps filter
	CIMRON (A)	6100 j v	3 manual	.001	999.9	±.01 ±1 digit	manual	f	auto-matic	•	• 10G @ bal-ance	30cps -10kc •	none	none	.0001	99.99	up to 100v 50kΩ
33	NON-LINEAR SYSTEMS (A)	V44 j	3 manual	.001	999.9	0.01 fs +1 dig	auto-matic	d	auto manual remote	200 const-ant	10M	30cps -10kc •	BCD & dec-imal	l m n o p	-	-	-

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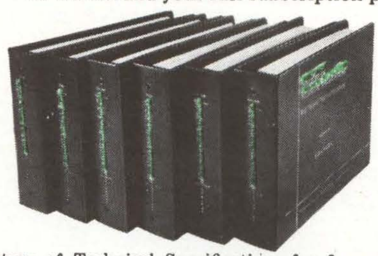

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DIGITAL VOLTMETERS

Type	MECHANICAL Width Inches	Height Inches	Depth Inches	Wt. Pounds	Price Dollars	NOTES	FOOTNOTES
R	19	5 1/4	14	28	1580.00	4. Absolute; rms sum of systems tolerances. 8. Balance time: 500ms average, 750ms maximum. 10. See AC digital voltmeter sec. 11.12. BCD or 10 line decimal to drive printer special.	l. Flexowriter. m. Electric Typewriter.
C	17	5 1/4	14	26	1330.00	8. Bal rate:30 steps/sec,typical bal time 1sec. 9. On 9.999V; 11MΩ on 99.99 & 999.9V rngs. 10.See AC digital voltmeter sec. Front panel plug-in permits add.of AC,preamp & ohms conv.	n. Card Punch. o. Tape. p. Digital Recorder
R	19	10 1/2	15 1/4	65	6185.00 FOB dest.	10. See AC digital voltmeter sect. Millivolt ranges with model 140 preamp. 11. Outputs provided for parallel decimal & parallel binary coded decimal. 5ms balance time.	v. Ratiometer also.

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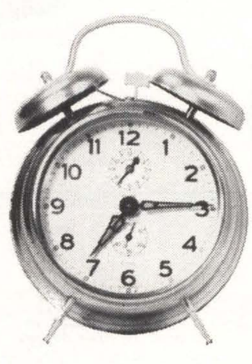

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Delay Range (μsec)	4-14	4-14	Max. 1000	Max. 1500	Max. 2000	Max. 2200	Max. 3500	Max. 6500	Max. 4500	Max. 9000	Max. 15,000	Max. 20,000
Case Size L x W x H (Inches)	5 x 1 x 7/16	5 x 1 x 7/16	3 1/4 x 3 15/16 x 7/16	4 1/4 x 4 7/8 x 7/16	4 1/4 x 4 7/8 x 3/4	4 1/2 x 5 1/2 x 3/4	6 x 7 x 7/16	6 x 7 x 3/4	9 1/2 x 10 1/2 x 7/16	9 1/2 x 10 1/2 x 3/4	9 1/2 x 10 1/2 x 1	9 1/2 x 10 1/2 x 1 1/2
Maximum Storage Capacit RZ (Binary Bits)	28	28	1000	1500	2000	2200	3500	5000	4500	9000	10,000	10,000
Bit Rate RZ (Megacycles)	0-2	0-2	0-1	0-1	0-1	0-1	0-1	0-0.8	0-1	0-1	0-0.7	0-0.5
INPUT												
V-in (Volts)	15	15	15	15	15	15	15	15	15	15	25	25
I-in (MA)	50	50	50	50	50	50	50	50	50	50	80	80
Z-in (Ω)	300	300	300	300	300	300	300	300	300	300	300	300
L-in (μH)	15	15	30	30	30	30	30	30	30	30	60	60
Pulse Width (μsec)	0.20	0.20	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.8	0.8
Rise & Fall Time (μsec)	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
OUTPUT												
V-out (MV)	70	20	20	20	10	10	10	10	10	5	5	2
Z-out (Ω)	1500	1500	1500	1500	1500	1500	4000	4000	4000	4000	4000	4000
L-out (μH)	80	80	150	150	150	150	150	150	150	150	300	300
(RZ) Pulse Width (μsec)	0.5 ±0.05	0.5 ±0.05	1.0 ±0.1	1.0 ±0.1	1.0 ±0.1	1.0 ±0.1	1.0 ±0.15	1.25 ±0.15	1.0 ±0.15	1.0 ±0.2	2.0 ±0.2	2.0 ±0.2
Signal to Spurious Noise (Static)	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	8:1	6:1
Signal to Spurious Noise (Dynamic)	5:1	5:1	5:1	5:1	5:1	5:1	4:1	4:1	5:1	4:1	4:1	3:1
MECHANICAL												
Volume (Cu. In.)	2.2	2.2	5.5	9.4	15.6	18.6	18.4	31.5	43.5	75	100	150
Weight (lbs.)	0.2	0.2	0.4	0.6	1.0	1.2	1.1	1.25	2.7	3.0	3.1	3.4
Mounts*	TS	TS	TBI	TBI	TBI	TBI	TBI	TBI	EMTI	EMTI	EMTI	EMTI
ENVIRONMENTAL												
Opt. Temp. Range (°C)	0-80	0-80	0-55	0-55	0-55	0-55	0-55	0-55	0-55	+10 to +40	+10 to +40	+10 to +40
Max. Delay Change Due to Temperature (μsec)	±0.04	±.005	±0.1	±0.1	±0.1	±0.1	±0.1	±0.15	±0.1	±0.1	±0.2	±0.3
(Non-operating) Shock	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	50 g, 11 ms	Normal Handling	Normal Handling	Normal Handling	Normal Handling
Vibration (Non-operating)	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	20 g, 5-2000 cps	Normal Handling	Normal Handling	Normal Handling	Normal Handling

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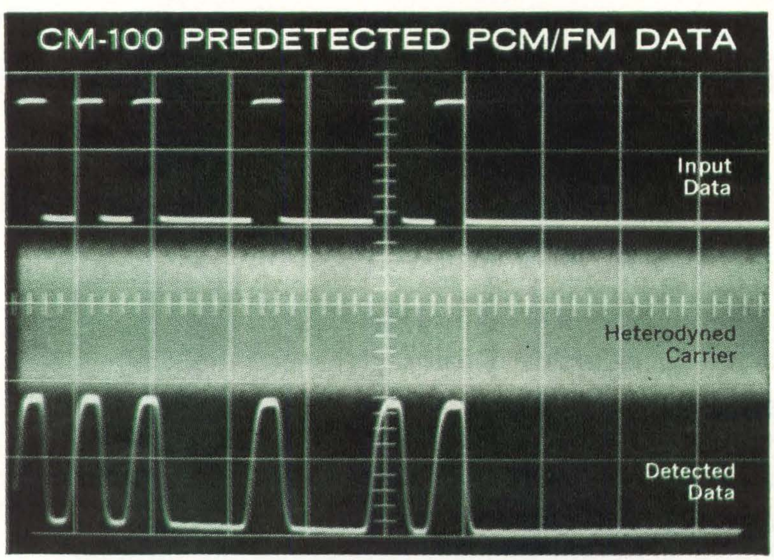

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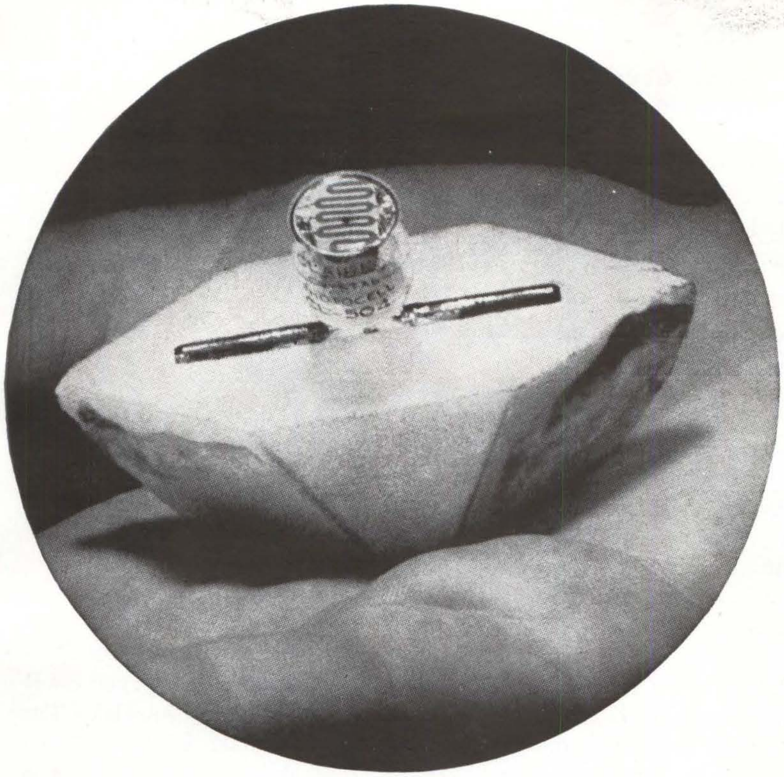
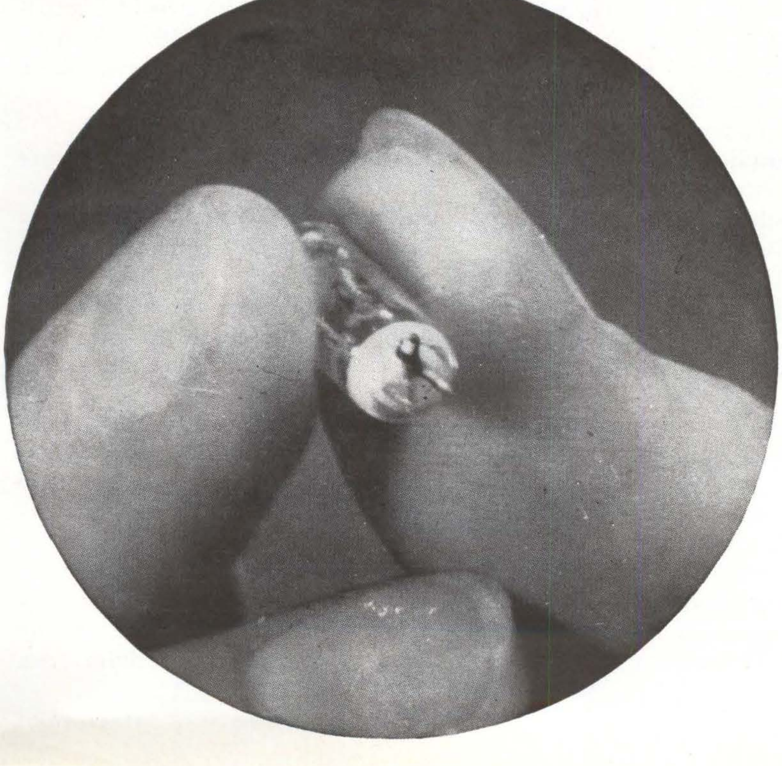


E-FIELDS *can be measured with dipole probe loaded with light-modulated photoconductor*

Light-modulated probes with no connections to detection system remove disturbing effects of leads on antenna E and H-field measurements. Current distribution along an antenna can also be measured without restrictions on antenna shape or size

HOW TO MEASURE FIELD PATTERNS WITH PHOTOSENSITIVE PROBES

By KEIGO IIZUKA
Gordon McKay Laboratory
Harvard University
Cambridge, Massachusetts



NEAR-FIELD PATTERNS of half-wave dipoles and current distribution along antennas can be measured without restrictions on antenna size and shape. All mechanical and electrical connections between the probe and the detection system are eliminated along with their disturbing effects on measurements. The concept used in this new measurement technique might also be extended to display instantaneous field patterns on an oscilloscope.

Distribution of an E field (or H field) is determined by measuring

H-FIELDS *as well as current distribution along an antenna can be measured by shield-loop probe*

INSTANT FIELD PATTERNS

Making measurements, particularly those associated with antennas, is often a chore. However, dependable quantitative information is needed at least as much in this as in other areas of electronics. Both the tediousness and the uncertainty in antenna field measurements are reduced by the conceptually simple approach investigated by the author. He even describes a system that might provide instantaneous field pattern displays.

the modulated signal reflected from a small dipole (shielded loop). The dipole is loaded with a photocell that is illuminated by a chopped light beam. Current distribution is measured by sliding along the antenna a small shielded-loop probe that is center-loaded with a photocell. Both the near-field pattern and current distribution measured by these probes have been found to be in general agreement with those theoretically determined.

The size of the probes generally used to measure electromagnetic field intensity can usually be reduced so that their disturbing effects on the field to be measured can be ignored. However, the disturbing effects of lead wires between the probe and the detection system are often difficult to reduce to negligible proportions. These effects are eliminated by the photomodulated probe, which is particularly important close to the antenna where any small disturbances can affect results.

OPERATING PRINCIPLE — To measure an electromagnetic field, a small dipole is placed in the field. The signal reflected from the dipole is proportional to the component of the E field that is parallel to the dipole axis. Hence, the E field at the position of the dipole is indicated by the intensity of the signal reflected by the dipole probe.

In practice, it is often difficult to separate the small dipole-reflected signal from the incident wave, from an unwanted signal reflected from the structure supporting the probe or from any other disturbances. To overcome this difficulty, the scattered signal from the probe is modulated by periodically varying the impedance of the photocell load. The amplitude-modulated reflected wave can then be easily separated from the unmodulated incident wave or other disturbances.

The entire arrangement used in experiments to measure the field pattern of a dipole (or monopole over an image plane) using the photo probe is shown in Fig. 1. A 600-Mc signal is fed to the hybrid junction. One arm of the junction is connected to the antenna under test and the other arm is connected to an adjustable dummy load. The hybrid junction is balanced in the absence of the probe by adjusting the dummy load so that the detecting system is completely decoupled from the oscillator. The dipole probe loaded by the photocell is then introduced into the field. The scattered signal reflected from the probe is received by the same antenna and is fed through the junction to the detection system.

Input to the detecting system is proportional to the square of the field-intensity distribution function of the antenna under test at the position of the probe. The basis for this relationship is that current induced in the probe by the monopole field is proportional to the field-intensity distribution function (field factor) at the position of the probe, and the reradiated signal resulting from this current and received by the monopole is also proportional to the field distribution function.[1,2]

LIGHT MODULATION — Impedance of the photocell is varied periodically by illuminating it with a chopped light beam. Thus current in the dipole and the scattered signal produced by it are amplitude modulated.

In the test structure in Fig. 2, the wooden frame was built in front of a vertical aluminum image plane. A half-wave, 600-Mc monopole was mounted horizontally on the plane. The horizontal polyfoam ($\epsilon_\lambda = 1$) table in front of the image plane provides support for the probes. Absorbing materials were arranged around the edges of the image plane to reduce reflections.

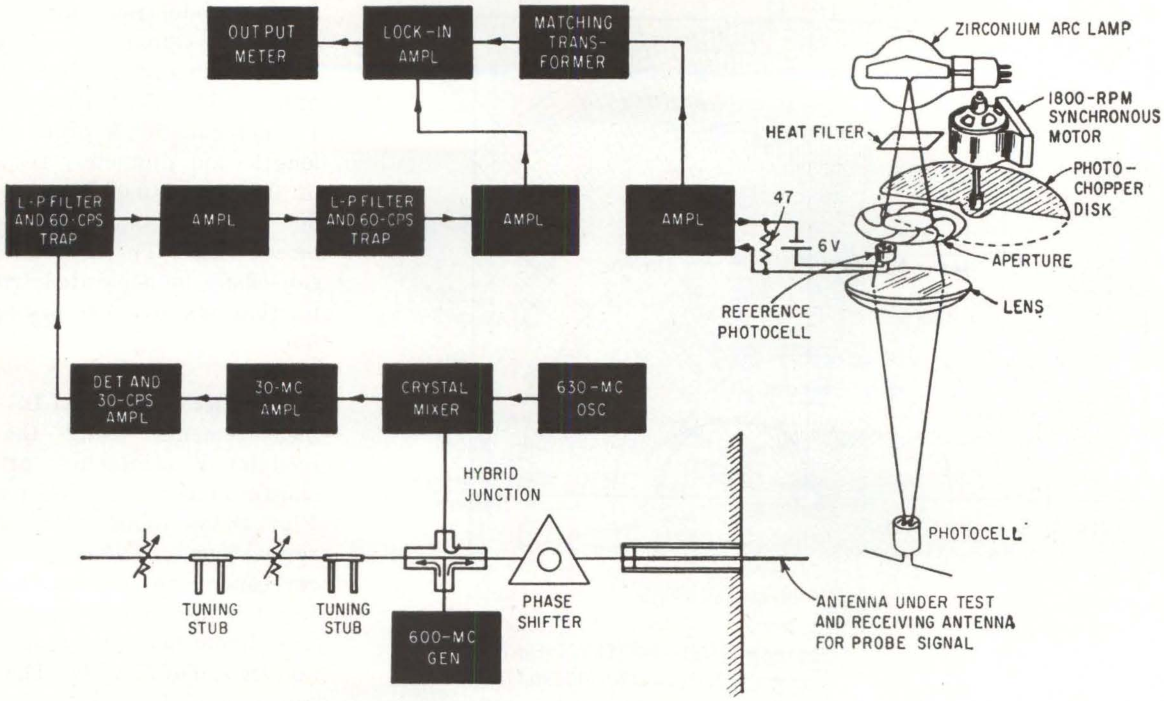
The thin dipole shown in the first photograph was secured on the boat-shaped piece of polyfoam and was center-loaded with a CL 504 photocell with its sensitive surface upwards. A sharp polystyrene needle was installed at the bottom center of the piece of polyfoam. This assembly is inserted into the polyfoam table, on which elliptic and hyperbolic coordinates are drawn. Height of the assembly is fixed so that the dipole probe is at the same level as the source of the image plane.

Light to the photocell was provided by a 300-watt zirconium arc lamp. The light beam was square-wave modulated by a chopper made from a thin Pyrex glass disk. The chopper disk, half of which was painted with carbon black, was driven by an 1,800-rpm (30-cps) synchronous motor. Light flux was adjusted by an iris and focused uniformly over the entire photocell surface by a lens. The part of the spectrum near the infrared is filtered out by a heat trap placed between the lamp and the lens.

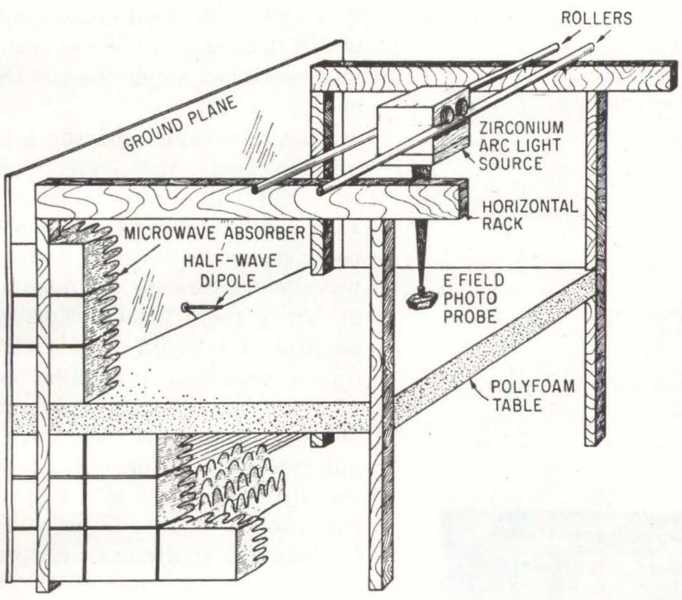
The entire light assembly was housed in an aluminum casing with forced-air ventilation. The casing was suspended from four wheels that roll on two cylindrical rods. The rods, in turn, roll on a horizontal wooden rack. The light assembly is thus movable in a plane so that a constant distance can be maintained between the light source and the probe.

REFERENCE CELL—A reference photocell exposed to the same chopped light beam was installed in series with a 47-ohm resistor and a 6-volt battery inside the casing. The potential across this resistor is amplified and fed to the reference terminal of the lock-in amplifier in Fig. 1.

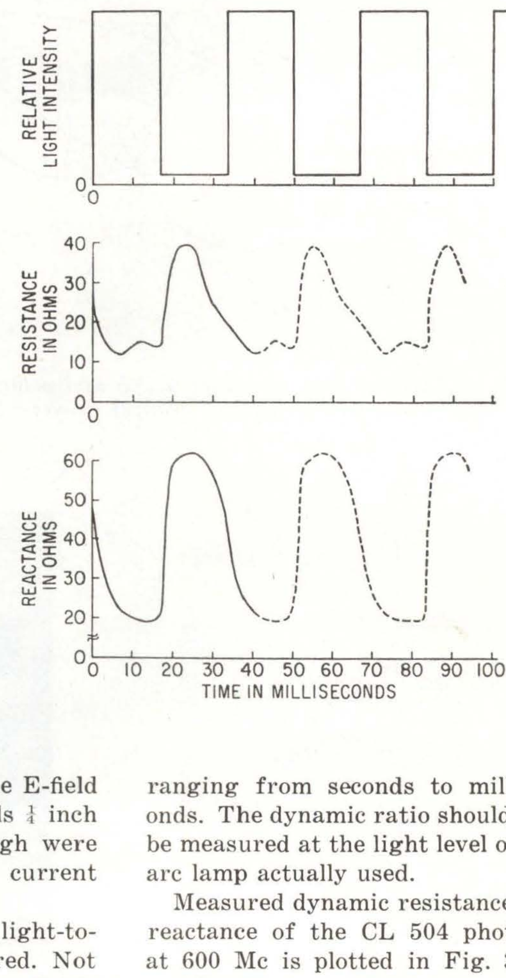
As modulating frequency is increased, the low-frequency noise that is associated with the surface and barriers of the photocell is decreased. However, the ratio of light-to-dark impedance is also decreased because the light is switched on and off more rapidly than photocell conductivity can



EXPERIMENTAL *arrangement was used to measure electromagnetic fields by a light-modulated scattering probe—Fig. 1*



STRUCTURE *provided support for the probe and the modulated light source—Fig. 2*



DYNAMIC *impedance is shown for photocell used at 600 Mc—Fig. 3*

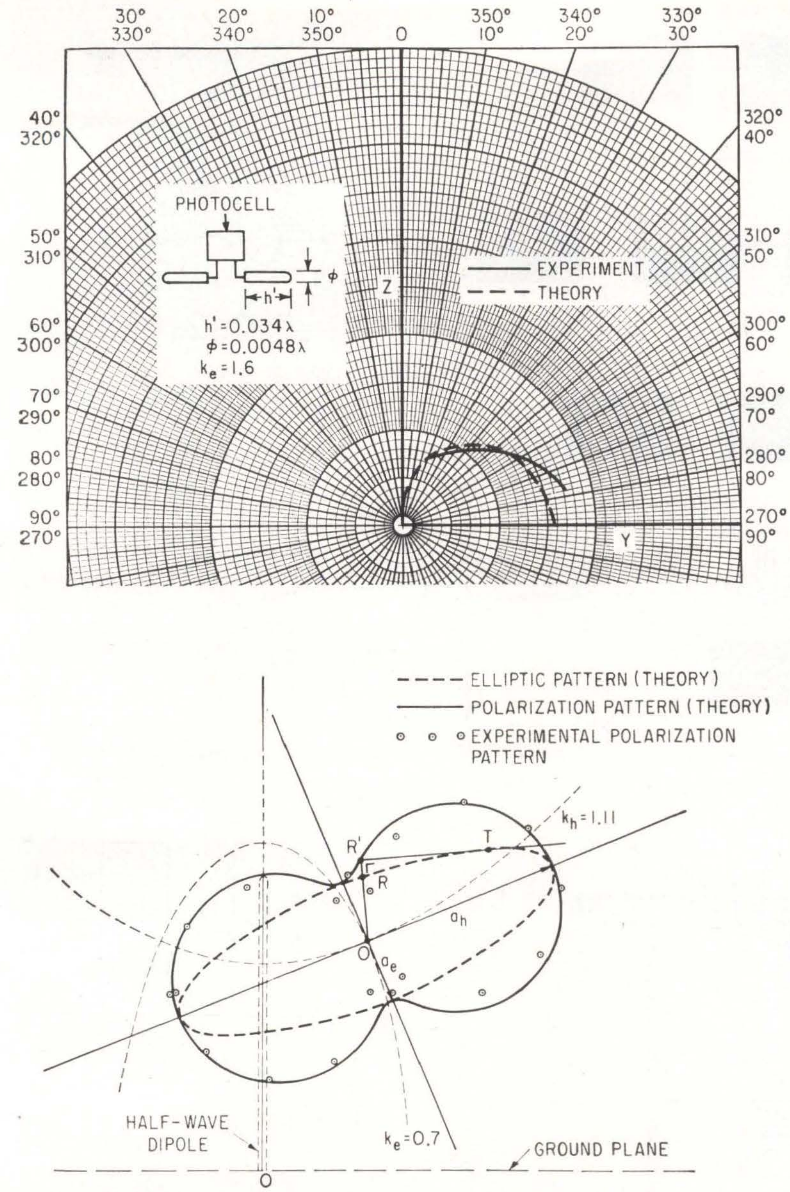
reach its maximum and minimum values. This fact was considered in choosing the 30-cps modulating frequency, as well as the problems of 60-cps pickup, mechanical vibration and stability of the light chopper.

Commercially available cadmium-selenide photocells were used as photoconductive loads for the probes. Clairex Corp. type CL 504 photocells ½ inch in diameter and ½ inch high were used for the E-field probe and CL 604 photocells ¼ inch in diameter and ½ inch high were used for both H-field and current probes.

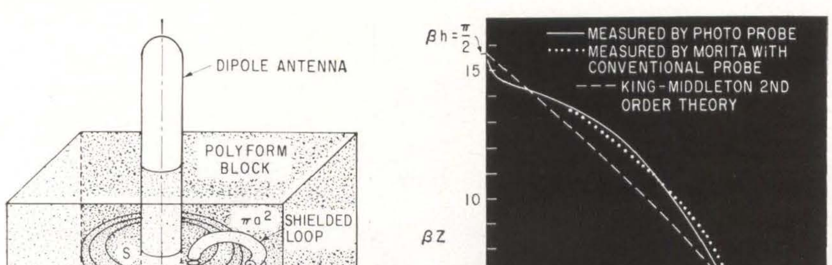
The dynamic ratio of light-to-dark impedance was measured. Not only is no information available about this ratio at frequencies as high as 600 Mc but rise and decay times depend greatly on light levels, ranging from seconds to milliseconds. The dynamic ratio should also be measured at the light level of the arc lamp actually used.

Measured dynamic resistance and reactance of the CL 504 photocell at 600 Mc is plotted in Fig. 3. A previously reported technique was used to measure this nonstationary load impedance.[3]

From the measured difference be-



RADIATION *pattern in upper graph and polarization pattern beneath it show close agreement with theoretical curves—Fig. 4*



CURRENT *distribution along an antenna measured with shielded-loop probe at left agrees with conventionally measured and theoretical curves at right—Fig. 5*

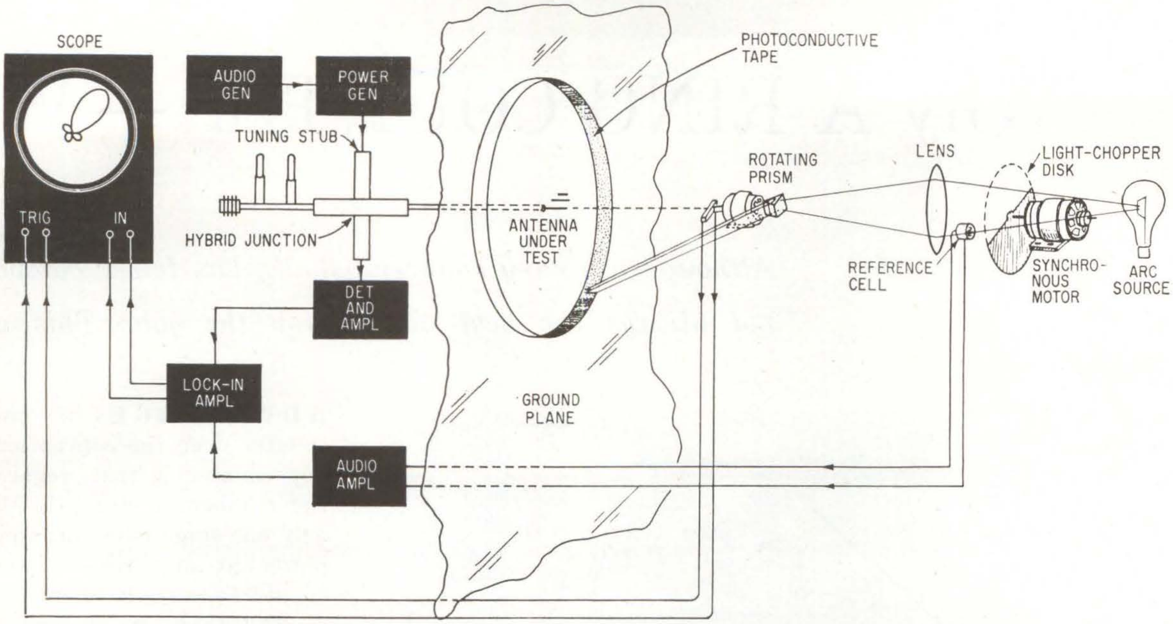
tween the light and dark impedances, modulation factor of the scattered signal from the dipole loaded with a photocell can be determined.[1] The modulation factor was 1.2 percent for a probe having a length and diameter, respectively, of 0.034 and 0.004 wavelength at 600 Mc. This small value proved to be sufficient. The modulated signal can easily be separated from noise fluctuations by the lock-in amplifier.

MEASURING E FIELDS—Actual measurements using the photo-modulated scattering probe are shown in the radiation pattern in Fig. 4 top along with the theoretical curve. These measurements correspond to one quarter of the familiar doughnut-shaped pattern. The dipole has its center at $Z = 0$ and its end at $Z = \pm h$. The confocal coordinates k_e and k_h are the reciprocal eccentricities $1/e_e$ and $1/e_h$ of a family of ellipsoids and a family of hyperboloids with foci at $Z = \pm h$. The field component E_α, which is tangential to the ellipsoid, was measured along the circumference $k_e = 1.6$.

Another example of the kind of measurements that can be made with this apparatus is shown in Fig. 4 bottom. It is the near-field polarization pattern of a quarter-wave monopole over an image plane drawn in correct proportion at the position of $k_e = 0.7$, $k_h = 1.11$. The dipole measures a so-called polarization pattern when it is rotated 360 degrees around the point O but not the polarization ellipse. When the dipole is placed in the direction OR, probe response is proportional to the greatest dimension of the ellipse measured normally to OR, which is OR'.

Agreement between the measured and theoretical values is good. Measuring field intensity so close to the antenna would be difficult using any other means, since the results would be affected by any small disturbance.

MEASURING H FIELDS—The analogy between electric and magnetic dipoles indicates that if a small loop instead of a dipole were loaded with a photocell, it would receive and scatter a signal proportional to the H field that links with



OSCILLOSCOPE *field pattern displays may be possible with an arrangement like this—Fig. 6*

the loop. Such an H-field probe is shown in the second photograph. The loop is covered by a shield that has a gap at the center to reduce the effect of the E field, which is parallel to the connecting line between the gap and the center of the loop.[1]

The shielded-loop photo probe was made of a special thin copper coaxial cable 22 mils in diameter and a CL 604 photocell. Outer diameter of the loop is 67 mils or 0.0014 wavelength at 600 Mc. The probe was constructed under a microscope and may be the smallest probe for measuring the H field in existence.

CURRENT DISTRIBUTION — This versatile technique permits current distribution along an antenna to be measured, since the magnetic flux that encircles the antenna is nearly proportional to antenna current. Hence current distribution along the antenna can be measured by sliding the probe along the antenna at a constant small distance from it.

The current probe was mounted in a straight hole in a polyfoam block of relatively high density. It was mounted so that the gap in the shield faced the hole (antenna), as shown in Fig. 5 left. Current distribution is measured by sliding the probe and polyfoam casing along the antenna. The distance between the probe and the antenna was 0.003 wavelength.

Current distribution along a half-wave dipole measured using this probe is shown in Fig. 5 right. For comparison, results obtained by T. Morita using a conventional shielded-loop probe moved along a slot in the antenna and a theoretical curve by R. W. P. King are included. The three curves are in good agreement except near the tip, which has been discussed in a previous report.[1]

During these experiments with photomodulated scattering probes, it was observed that probe sensitivity was unchanged or increased when the photoconductive cell was replaced with a photovoltaic cell. This observation may be explained by the fact that the change in internal resistance of the photovoltaic cell is about as large as that in a photoconductive cell.

PATTERN DISPLAYS—In work associated with this project, it was found that a strip of cadmium selenide evaporated on a thin piece of ceramic material behaves like a small strip dipole antenna. The surface of this device could also be used as a probe, but its sensitivity is somewhat lower than a dipole loaded with a photocell. This principle might be used to display an instantaneous field pattern on an oscilloscope using an arrangement like that shown in Fig. 6. A photoconductive tape with the sensitive side facing in is placed around the circumference of a circle centered at the antenna under test. A revolving prism positioned at the center of the antenna away from the ground plane rotates a light beam shaped like a narrow strip.

As the light beam rotates around the conductive tape, the source antenna receives a scattered signal that is proportional to the square of field intensity distribution on the circumference. If the received scattered signal is amplified and fed to an oscilloscope that is swept at prism rotation speed, the radiation pattern can be displayed on the oscilloscope.

Since this technique does not require rotation of either the transmitter or antenna being investigated, it is particularly useful for measuring the field patterns of electronically scanned antenna arrays.

This research was supported by the Office of Naval Research. The author acknowledges the support of R. W. P. King and his suggestions about the manuscript and the assistance of D. MacMillan in constructing the experimental apparatus.

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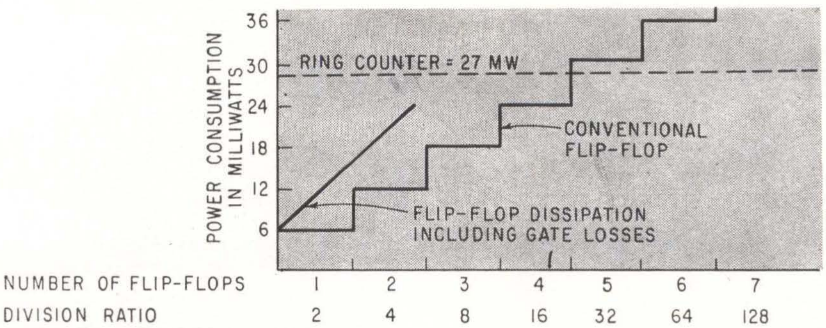
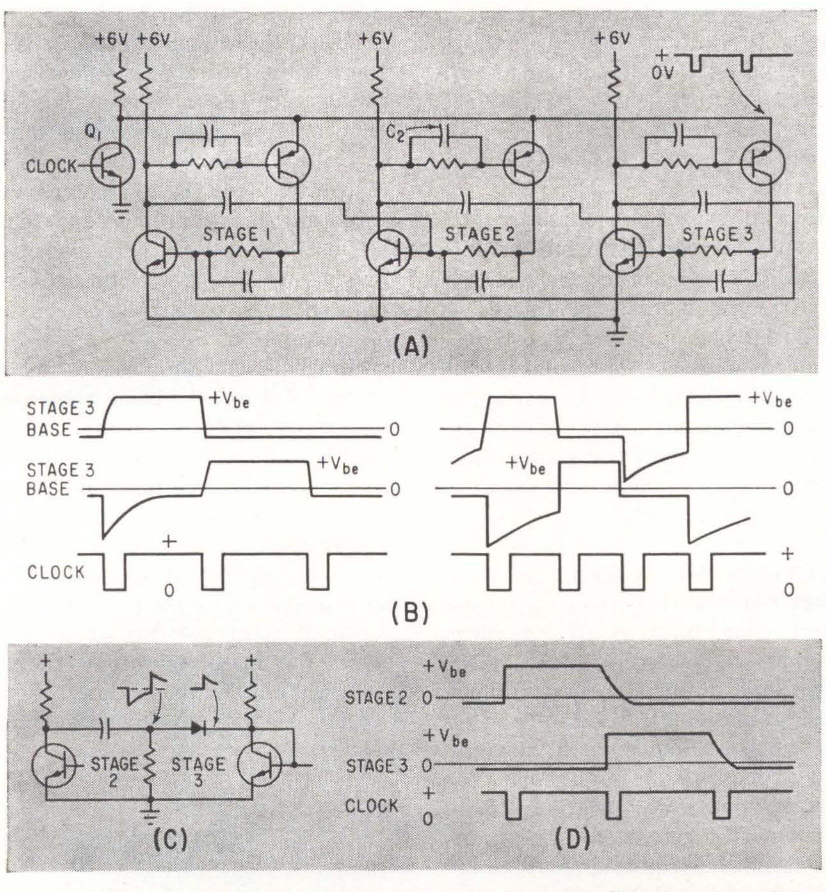
(3) K. Iizuka, A Method of Measuring the Time-Dependent Impedance of the Load, *Microwave Journal,* November, 1962.

Why A RING COUNTER—Why

Although a binary counter usually has fewer components
not always the best circuit for the job. This article



RING COUNTER *power consumption is almost constant regardless of number of stages, binary counter absorbs increased power for every added flip-flop—Fig. 1*



COUNT *is advanced in simple ring-counter by grounding pnp transistor emitters (A), critical pulsing occurs during turn-on (B), series diode improves interstage coupling (C), slows base-turnoff characteristics (D) —Fig. 2*

ADVANTAGE of the ring counter over the conventional flip-flop counter is that, regardless of the number of stages in the ring, only one stage is on and consuming power at any time. But binary counters always have one transistor conducting in every stage regardless of count.

Figure 1 shows the relative power consumptions and break-even point for binary and ring-counter circuits. Basic assumptions are 10 milliwatts consumption for the ring counter conducting stage plus 17 milliwatts for its clock circuit, while each flip-flop in the binary counter is assumed to take 6 milliwatts.

Two factors are not accounted for in Fig. 1. First, the ring counter stages do consume some power when off, generally 1 to 10 percent of these values. Second, the gating losses in conventional flip-flop combinations are not negligible. A third factor relating to readout is that if all digital combinations are to be gated out, diodes and resistors required for gating can make the component count of a binary counter much greater than a ring counter.

Another advantage to the ring counter is that when large power outputs are required, one transistor in each stage can be a high-dissipation unit while the other need be capable only of supplying base current to the output transistor.

COUNTING ERRORS—Since the ring counter transfers its count consecutively from stage-to-stage, noise-generated miscounts affect the least significant digit; however, if noise triggers a conventional shift register the whole count can be lost.

The ring counter flip-flop consists of an *npn-pnp* pair of transistors, with one transistor the output stage and the other transistor its base-

Not A BINARY?

By JOHN DURIO, Systems Development Department,
Collins Radio Company, Newport Beach, Calif.

for a given count, it is gives some reasons why

current supply switch. Figure 2A shows such a circuit. There are actually two sources of base current for the *npn* output transistor. One base supply is a steady-state source; the other is a transient source. To explain this transient source, first assume that stage 2 in Fig. 2A is on, where it will remain indefinitely unless a clock pulse is introduced.

One method for turning a stage on is simply to momentarily ground the collector of the output stage, thereby grounding the *pnp* base resistor as well. This places the *pnp* base at a negative potential relative to its emitter, turning the *pnp* transistor on. A base current supply is now provided for the *npn* transistor, so that it turns on too. When the ground is removed, the *npn* collector remains near ground, with the stage left in the on state.

When a clock pulse occurs, the collector of the clock transistor goes to ground. This grounds emitters of all *pnp* transistors and turns off the conducting *pnp* transistor of stage 2. Stage 2 is then turned off. Now the *npn* collector goes from ground to +6 v and provides a forward bias path from the +6 v supply, through the collector resistor and through C_2 to the base of the stage 3 *npn* transistor. The stage 3 *npn* transistor goes on and the clock is removed before the R-C discharge is dissipated. With the removal of the clock pulse the emitters of all the *pnp* transistors now have a positive voltage appearing on them. Since the stage 3 *npn* collector is at ground because of the R-C discharge, the stage 3 *pnp* transistor turns on and supplies the steady-state forward bias for the *npn* transistor, thereby holding stage 3 on.

CONSERVING THE POWER

If power supply is limited, as in a space satellite, then economizing on power consumption is a major design problem. The ring counter serves well here, since only one stage conducts for any count. Although binary circuits are fashionable, ring counters should be scrutinized for other advantages too—they provide decimal readout with the utmost simplicity, can deliver high power outputs without auxiliary transistors, and don't suffer from serious counting errors when noise spikes add a few false triggers

PROBLEMS—Transfer of a count is caused by turning off a preceding stage. However, one high-frequency-limiting factor is created by turning on a stage. The turn-on waveform is transferred to the following *npn* base as a large negative spike which may even exceed the BV_{EBO} of the transistor. The timing of the negative spike is exactly wrong, Fig. 2B, because as the spacing of the clock pulses decreases, this negative charge actually opposes the turn-on positive transient that is due to occur with the next clock pulse.

A simple method for overcoming this problem is to place a diode in series with the capacitor as shown in Fig. 2C. This diode blocks the transfer of the negative spike across the capacitor and onto the base of the next stage's *npn* transistor.

At still higher frequencies another problem occurs as seen by the base circuit waveshapes shown in Fig. 2D. Even with speed-up capacitors the trailing edge of the base waveshapes show that as frequency is increased the base of the transistors will still be significantly positive just when the negative turn-on pulse arrives. This leads to erratic triggering and double pulsing.

To eliminate this problem another diode R-C network is introduced, which uses the large negative spike that was previously inhibited from the base of the following transistor. The new R-C network routes the negative spike to the base of the preceding stage to speed up its negative excursion.

Now a clean base waveshape with a definite negative spike is observed in Fig. 3A. This negative spike can be controlled by adjusting the value of the capacitor so that the BV_{EBO} is not exceeded. This adjustment is not possible with the simple capacitor coupling of Fig. 2A.

CLOCKING—Another problem is the many turn-on and turn-off actions that happen sequentially. In transferring a count it is necessary to ground the clock lines, thus the delay and rise of clock transistor potential is first in the sequence of switching actions. This is followed by the ON stage *pnp* transistor storage and fall times and later by the storage and fall time of the complementary *npn* transistor. All of these actions are followed by the turn-on sequence of the succeeding stage, where the *npn* delay and rise times are followed by *pnp* delay and rise times. Thus 10 transients are involved, the first few of which are in series while the last vary with transistor, capacitor and resistor tolerances and temperatures.

However, it is necessary to insure that the R-C time constant provides enough base current to keep the turning-on *npn* transistor in conduction long enough for its associated *pnp* transistor to turn on sufficiently to provide steady-state current. Thus the clock period must be long enough for the turning-on *pnp* transistor to conduct in worst-case conditions and short enough to prevent the *npn* transistor's transient phase current dropping to an insufficient value.

Another method of clocking that eliminates some of the numerous small transients is shown in Fig. 3B. Here the clock goes to the *npn* transistor's base through a diode and first turns off the *npn* transistor then the *pnp* transistor. Thus, the *pnp* storage and fall times are eliminated from the sequence of events, and the *pnp* turn-off parallels some of the other small transients.

This method of clocking allows for operation at frequencies where the *pnp* actually fails to function. At such frequencies the R-C turn-on current lasts for the entire clock period and the *pnp* is not needed. This region of operation can be marginal since external loading dictates how much base current is required. Breadboard operation has been achieved in the 2.5 to 5.0-Mc range using this technique. A frequency increase of one order of magnitude should be simple to accomplish.

All this implies that for operation at various frequencies, the driver is a one shot followed by an inverter, or inverters, the last stage of which is a clock transistor.

DOUBLE COUNTING—A further problem is that of double counting. This is, unfortunately, a natural phenomenon in ring counters.

When specifications call for a wide temperature range, large derating factors and large fan out, double counts are inevitable. If for example, it is necessary to derate a typical transistor beta from 50 to 10 because of worst-case low-temperature considerations, and yet accommodate a nontypical high-temperature beta of 200, even though the clock resistor limits the amount of available drive, this same resistor must provide enough drive for the beta = 10 case. Thus at high temperatures numerous transistors can conduct if they are prone to do so because of noise, sloppy turn-off and so on. Also a large fan out multiplies the problem. One way of eliminating the fan-out problem is to permanently load each stage with one inverter only. This in addition to a temperature sensitive resistor in the place of the normal clock resistor, can almost completely eliminate the problem of double pulses.

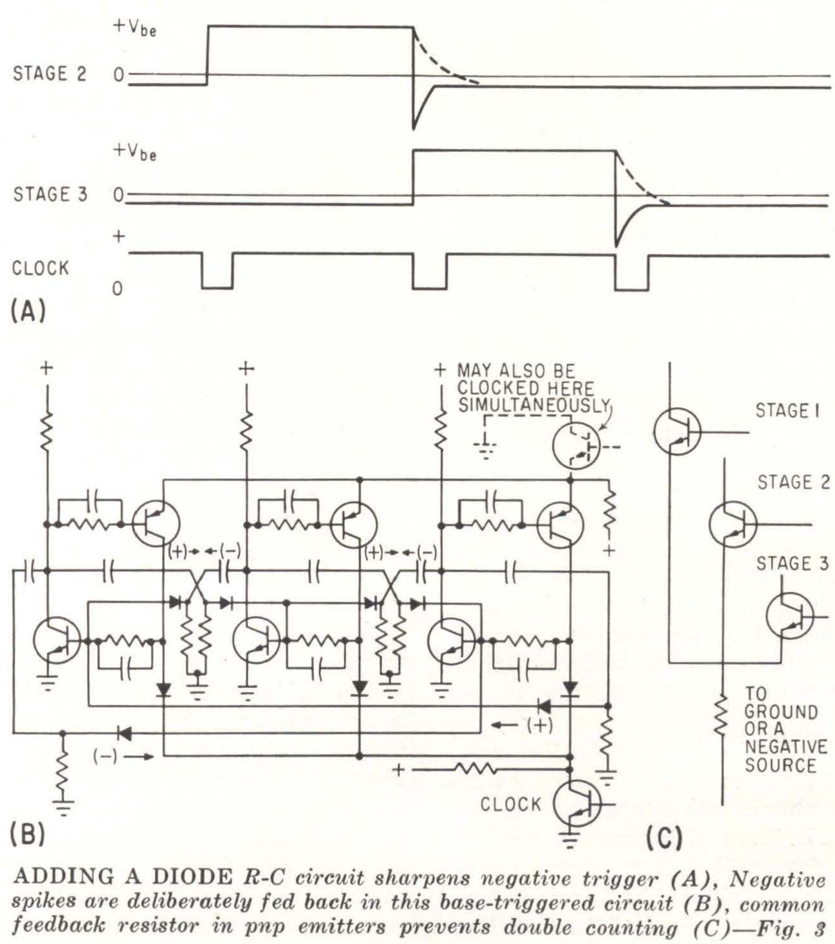
Another method that can be used is that of the common *npn* line resistor shown in Fig. 3C.

The resistor can be returned to a negative source to prevent the collector going too far positive. This resistor provides degenerative feedback during normal operating, and if more than one stage attempts to go on, positive voltage increase at the emitters tends to turn all stages off. The stage that is receiving the R-C transient will come back on when the other interfering stages have been turned off. This method is extremely effective and can be improved if the negative source is a forward biased diode or diodes. The diode drops decrease with increase in temperature and this causes the *npn* emitters to become more positive, thus counteracting the increased beta.

Another improvement is to replace the feedback resistor with a device that increases its resistance with temperature. This also makes the feedback greater at high temperatures. A saturated transistor could be used in place of the feedback resistor since the collector-to-emitter drop increases with temperature.

A current-limiting device can eliminate double pulsing if the feedback resistor is replaced by a limiter of the proper current capability.

For example, if the collector resistor draws one milliampere and the stage can drive up to two loads of 0.5 milliampere each, the current limiter should have a 2.0-ma rating. Each ring-counter flip-flop should be loaded fully either by actual or dummy loads. With this configuration, the circuit is no longer beta sensitive because now only one stage will come on at a time, there being no collector current available for an additional stage. Also if the fan out is not too great, and if the collector load resistor is made much lower than the external loads, the necessity of fully loading each stage can be eliminated.



ADDING A DIODE *R-C circuit sharpens negative trigger (A), Negative spikes are deliberately fed back in this base-triggered circuit (B), common feedback resistor in pnp emitters prevents double counting (C)—Fig. 3*

PULSE RATE FOR PULSE RATES

Medical researchers can't be bothered fooling with complicated electronic gear. Thus, this equipment was designed to overcome some of the limitations of biomedical telemetry systems using phase or amplitude modulation. Key to the simplicity and reliability of the system is the pulse-rate modulator. The design can be applied to many other measurement problems

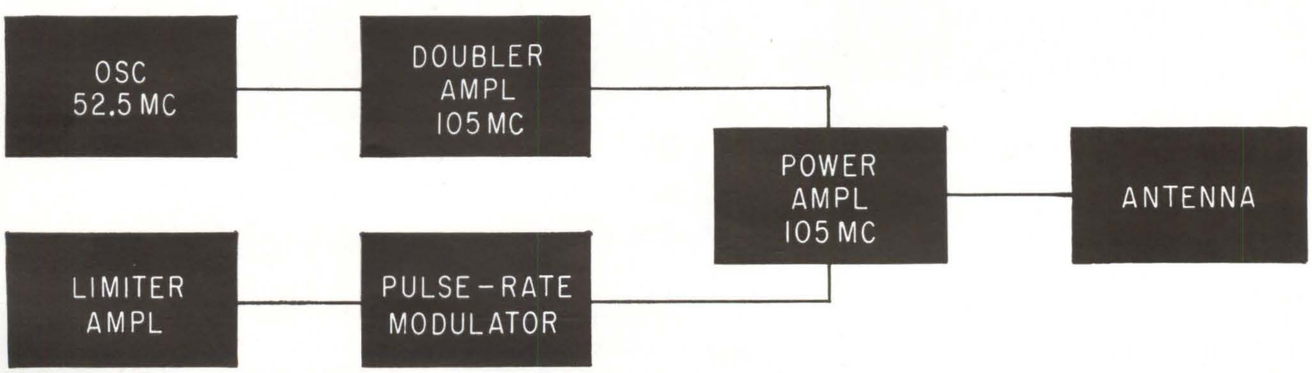
Designing a Simple Telemeter for Medical Research

Pulse-rate modulation technique cuts complexity, provides stable, compact single-channel medical research system

By A. G. POTTER and J. D. McMECHAN

Department of Electrical Engineering, Iowa State University, Ames, Iowa

SINGLE-CHANNEL telemetry systems for biomedical measurements should be simple, stable and have low power drain. To meet these requirements, a system using pulse-rate modulation (prm) was designed. Pulse-rate modulation turns the r-f carrier on in accordance with a pulse train whose pulse rate contains the base-band information. The system consists of a relaxation oscillator, or an astable multivibrator that samples the amplitude of the modulating signal. Its output is a pulse train whose frequency is linearly



TELEMETRY *transmitter has a power output of 80 milliwatts into a 50-ohm dipole antenna—Fig. 1* related to the amplitude of the modulating signal.

Although prm does not lend itself to multiplexing, either pulse-position or pulse-duration modulation could have been used if multichannel operation had been desired. However, equipment size, complexity and power consumption would have been increased.

Although the apparent increase in d-c to r-f efficiency derived from using prm is lost in generation of sidebands, this modulation technique was chosen because (1) the transmitter unit is reliable and simple, (2) the modulation information is not contained in the frequency of the r-f carrier, (3) the r-f signals can be demodulated by either an f-m or an a-m detector, and (4) there is considerable improvement in noise figure over a pulse-amplitude modulated system.

The transmitter, Fig. 1, was designed as a belt-mounted unit with a companion ecg amplifier for human telemetry. This was done to facilitate system testing and modification. The crystal-controlled oscillator operates at 52.5 Mc and drives a doubler amplifier with a gain of 3 to 6 db. Input to the doubler is an adjustable L-matching network, whereas the output circuit uses a conventional pi matching network. The final power amplifier consists of a pair of transistors connected in parallel running grounded base, class C, and matched through a pi network to a 50-ohm antenna load.

When running under steady r-f carrier conditions, the transmitter delivers 80 mw into a 50-ohm load. Under these conditions it draws 47 ma at a supply voltage of 9 volts. When using the pulse-rate modulator with a duty cycle of 2.5 percent, the unit draws 8 ma at 9 volts.

Under these conditions the doubler and final r-f amplifiers, which use 40 ma when operating continuously, draw an average current of 1 ma with the remaining circuits taking 7 ma. It is possible to decrease the average d-c drain to r-f peak power output ratio by reducing the current drain of the nonpulsed circuits.

RATE MODULATOR—The unijunction relaxation oscillator and limiter amplifier circuit, Fig. 2, generate output pulses $e_o(t)$ that turn on the doubler and final r-f amplifier for a fixed period of time at a rate dependent upon $e_i(t)$.

In designing the modulator circuit let average pulse repetition rate $f_o = 2500$ cps, pulse duration $d = 10\ \mu$sec, and maximum frequency deviation $\Delta f_{max} = 250$ cps. Modulating voltage (e_i) and the pulse-rate (f) are related by

$$V_1 + V_{E_{min}} + V_D = e_i + V_1 + V_{E_{min}} - e_i)\ \epsilon^{-f_4/f} \qquad (1)$$

where $V_1 = -7$ v, $V_{E_{min}} = 2$ v, $V_D = 0.6$ v, and $f_4 = 1/R_4C_4$. Rearranging and substituting the given numerical values into Eq. 1

$$f = \frac{f_4}{1n\,(5 + e_i) - 1n\,(4.4 + e_i)} \text{ cps} \qquad (2)$$

A plot of Eq. 2 in λ and e_i, where $\lambda = R_4C_4f$, is shown in Fig. 3A. The best linear approximation to this curve is a straight line having the equation

$$\lambda = 1.7\, e_i + 7.87 \text{ volts; } e_i \leqq 0 \text{ or} \qquad (3)$$

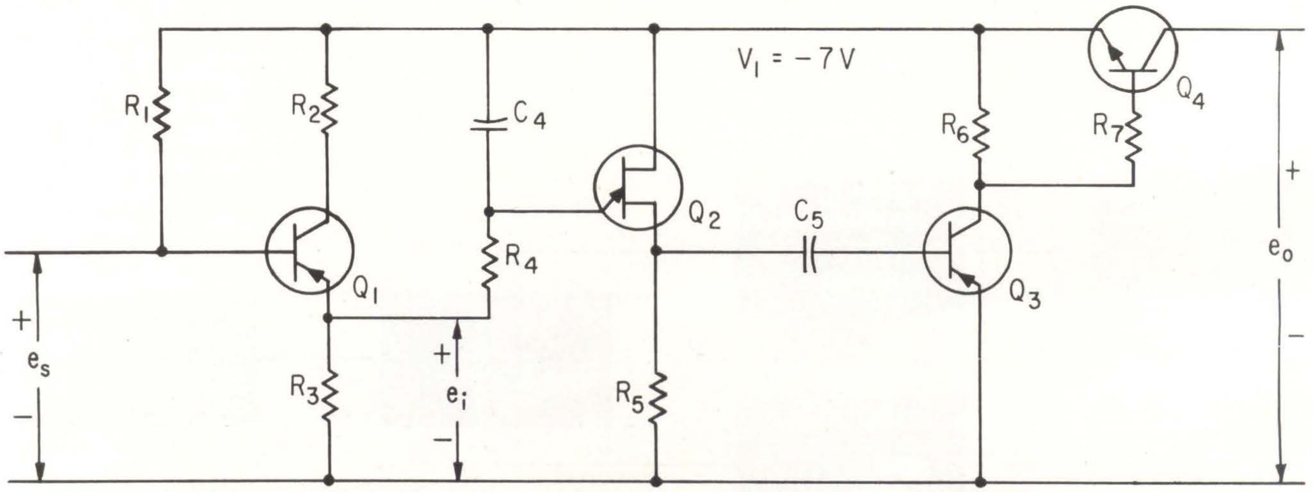
$$f = \frac{1.7}{R_4\, C_4}\, e_i + \frac{7.87}{R_4\, C_4} \text{ cps; } e_i \leqq 0 \qquad (4)$$

Let $e_i = e_m + V_B$, where V_B is the d-c component of $e_i(t)$, then calculate V_B and R_4C_4 to fit the conditions: (a) $e_i = 0, f = f_h = f_o + \Delta f_{max}$; (b) $e_i = V_B, f = f_o$; and (c) $e_i = 2V_B, f = f_l = f_o - \Delta f_{max}$.

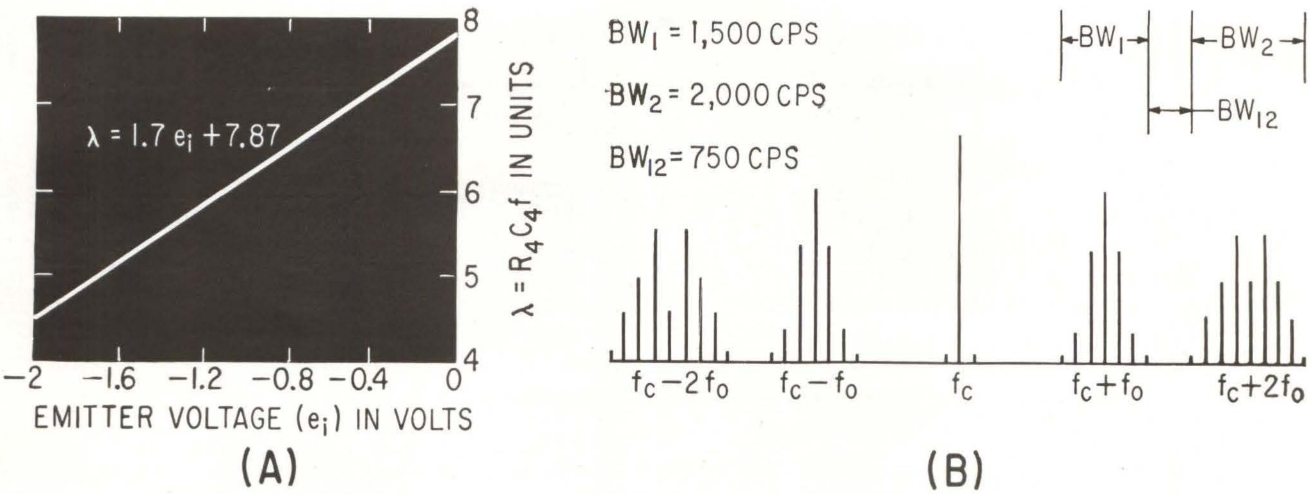
These conditions are imposed because the limiter must operate with one of its voltage limits equal to zero volts. The other condition equation needed to solve for R_4C_4 and V_B is

$$\Delta f_{max} = \frac{-1.7 V_B}{R_4\, C_4} \text{ cps} \qquad (5)$$

Solutions of Eq. 4 and 5 give $V_B = -0.425$ v and $R_4C_4 = 2{,}860\ \mu$sec. The limiter amplifier is then designed



UNIJUNCTION *transistor relaxation oscillator and limiter amplifier comprise the rate modulator—Fig. 2*



TRANSFER CURVE *for pulse-rate modulator shows a linear relation between pulse rate and modulating voltage (A). Spectrum of modulator output with two sideband groups (B)—Fig. 3*

so that limiting occurs at $e_i = 0$, and $e_i \leqq -0.85$ v. If an overall sensitivity of 500 cycles per volt is desired, the gain of the limiter amplifier must be 0.84.

For good temperature stability of the unijunction relaxation oscillator the value of R_5 is

$$R_5 \simeq \frac{0.7R_{BB}}{\eta V} \simeq 1{,}200 \text{ ohms} \qquad (6)$$

where η is the standoff ratio (0.5) and R_{BB} is the interbase resistance (6,000 ohms). The value of C_4 may be approximated by

$$C_4 \simeq \frac{d - 4V_{E_{min}}}{10V_{E_{min}}} \simeq 0.1 \,\mu\text{f.} \qquad (7)$$

where d is pulse duration in microseconds and $V_{E_{min}}$ minimum emitter voltage in volts. Using the product $R_4C_4 = 2{,}860$ μsec and the results of Eq. 7, $R_4 =$ 28,600 ohms. The oscillator has a linearity of better than ± 1 percent, a temperature coefficient of frequency of less than 0.01 percent per degree C, and a frequency variation with supply voltage no greater than 0.4 percent per volt.

TRANSMITTING ANTENNA—Belt-mounted, the antenna is a shunt feed dipole 0.65 meter long. The antenna is matched to a 50-ohm line by tapping through a 5 to 30-pf. capacitor to a point 10 cm from the center of the dipole. The antenna pattern is omnidirectional to within 3 db, when measured with a horizontal dipole 2 meters above the ground plane at a distance of 100 meters. During this measurement the dipole was worn by a person having a radius of 15 cm and was positioned approximately 1.2 meters above the ground plane.

SIGNAL DETECTION—A line spectrum diagram of the modulator output signal, Fig. 3B, shows the first two sideband groups for $\Delta f_{max} = 250$ cps and $f_{m max} = 250$ cps. The condition is the worst with regard to bandwidth, that is, the largest bandwidth is required for each sideband group.

Two methods were considered for receiving and demodulating this signal. First, a wide-band a-m receiver with circuits to restore the original pulse shape was proposed. The receiver would frequency demodulate the prm signal and filter out all frequencies above 250 cps. The second proposal was to use a relatively narrow-band a-m receiver to receive most of the r-f power in the signal, then after i-f amplification to use a narrow-band filter to retain only the carrier and the $n = 1$ sidebands. The receiver would frequency demodulate the prm signal and filter out all frequencies above 250 cps.

The second method was used. The receiver system is made up of three sections: a converter, tunable i-f receiver and frequency demodulator. The converter i-f is 26 to 30 Mc with a flat response over 104-108 Mc. The frequency demodulator consists of a transformer, clipper, Schmitt trigger and one-shot multivibrator followed by a 250-cps low-pass filter.

The receiving antenna now being used for outside monitoring is a stationary, 12-element, colinear type possessing about 6 to 8 db gain with broad beam width and wide frequency range.

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WHICH PERMANENT SHOULD YOU USE?

There are 18 different methods to choose from and a whole host of ways in which these methods can be applied. This table guides the user to an optimum choice of jointing technique

FOR PERMANENT CONNECTIONS alone, not counting disconnectable types, there are 18 different mechanical, chemical and thermal methods of joining conductors. In the table, a rating value from zero to 10 is assigned to each connector type for every performance category. A rating of 10 means that the connection method (top of table) is suitable in the category considered. Lower assigned values are considered less suitable, but values as low as 5 are sometimes acceptable. A zero value implies that the connection method is a poor choice, while a dash means it is not applicable.

		THERMAL				CHEMICAL		
PERFORMANCE AND COMPATIBILITY		Solder	Braze	Gas or Arc	Spot	Plating	Conductive Adhesive	Amalga
ELECTRICAL PROPERTIES	Low Resistance	9	10	10	10	8	3	8
	Resistance Stability	10	10	10	10	8	7	9
	Low Voltage	9	10	10	10	8	5	8
	High Currents	8	10	10	9	1	1	3
MECHANICAL PROPERTIES	Pulloff Force	9	10	10	10	1	1	8
	Low Creep	9	10	10	10	5	5	9
	Strength	9	10	10	7	3	4	4
APPLICABILITY TO THESE CONDUCTORS	Solid Wire	10	10	10	10	10	10	8
	Stranded Wire	9	9	8	0	10	9	9
	Insulated Wire	6	2	2	8	9	9	9
	Aluminum Wire	5	2	1	0	2	2	0
	Tinsel Wire	5	0	1	1	5	5	5
	Bus Bars and Structures	8	8	8	9	6	6	6
JOINING WIRE TO:	Wire	10	10	9	8	—	8	8
	Component	10	8	5	9	4	5	5
	Separable Connector	9	8	1	8	8	5	4
WIRE INSULATED CONNECTIONS	Pre-Insulation	0	0	0	1	1	8	9
	Post-Insulation	8	8	8	8	8	8	10
RESISTANCE TO ENVIRONMENTS	Hi-Temp	5	9	10	10	6	1	3
	Low-Temp	9	10	10	10	9	5	8
	Thermal Shock	8	9	10	10	7	7	7
	Vibration	6	7	10	9	2	1	7
	Salty and Humid Air	9	10	10	10	5	5	8
	Aging	9	10	10	10	8	5	8
	Hermetic	10	10	10	1	9	9	10
	Nuclear Radiation	9	10	10	10	9	1	5
COST ECONOMY	Tooling	7	4	3	4	5	9	7
	Connector	9	8	8	9	5	8	5
	Process	6	5	5	5	4	8	8
ACCESSIBILITY IN ASSEMBLY	Method Needs Little Space	8	5	4	8	5	8	8
	Ease of Repair	8	6	5	9	7	9	7

EIGHTEEN *headings list a wide range of connection methods, left-hand column*

ELECTRICAL CONNECTION

By JAMES H. WHITLEY, AMP Inc., Harrisburg, Pennsylvania

	MECHANICAL									
				Ultra-			Screws			
	Wire-	Metal	Cold	sonic					Twisted	Wire
imp	Wrap	Powder	Weld	Weld	Rivets	Eyelets	Wire	Terminal	Wires	Nuts
9	9	10	10	10	9	8	9	9	9	9
9	9	10	10	10	9	5	7	9	5	8
9	9	10	10	10	10	5	8	9	5	8
9	8	9	10	10	9	5	9	9	8	9
9	8	9	10	9	9	7	3	10	2	8
9	7	9	10	10	9	8	3	8	2	8
9	7	9	10	9	10	9	5	9	4	8
10	10	9	10	10	5	5	10	—	9	10
10	0	9	1	1	2	5	2	—	9	10
10	9	9	9	9	9	9	9	—	9	9
8	1	5	8	8	4	4	4	—	1	6
8	0	5	0	5	6	6	4	—	0	0
7	—	—	8	8	10	10	—	10	—	—
9	—	9	9	7	3	3	4	—	10	10
8	8	7	7	7	8	8	10	10	10	10
6	9	7	3	3	6	8	10	10	—	—
10	0	7	4	5	1	5	10	10	0	10
10	7	10	7	8	8	8	8	7	9	10
9	8	9	9	9	4	3	7	8	5	7
9	8	9	9	9	5	5	8	8	7	7
8	7	8	9	9	4	3	2	8	2	8
9	3	8	9	9	5	5	2	9	1	7
9	6	9	10	10	8	7	7	9	4	8
8	8	9	10	10	8	7	7	8	7	8
0	1	9	10	10	8	1	1	—	1	1
9	9	9	10	10	9	9	9	9	9	9
8	7	2	4	1	7	8	9	10	10	10
9	9	7	8	7	9	9	10	9	10	9
9	8	5	5	1	8	8	10	10	10	10
9	8	7	7	7	8	9	9	9	10	8
9	7	6	6	6	7	7	10	10	10	9

shows how they are applied

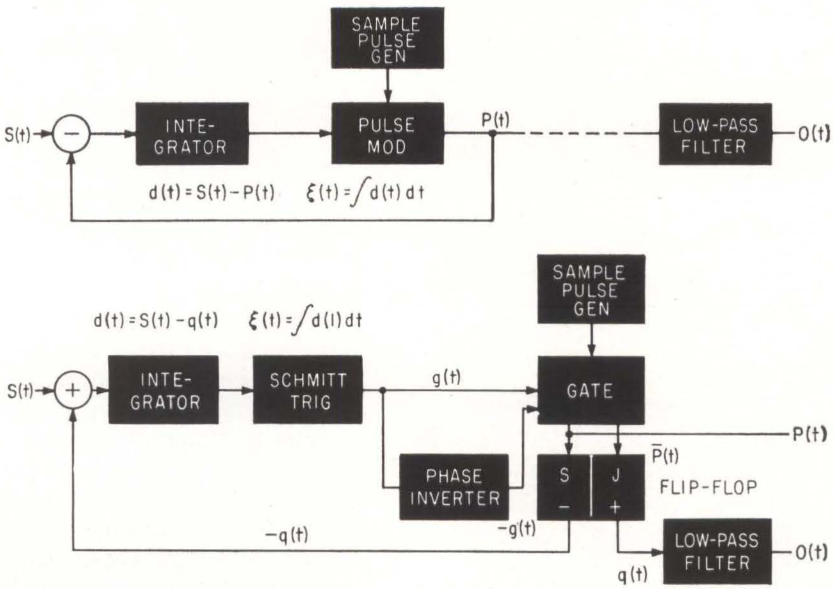
For example, a twisted-wire terminal has a rating of 10 under each of three cost categories, meaning it is economical, but a twisted wire terminal rates 1 for applicability to aluminum wire because troublesome oxides form quickly making it unsuitable for that application.

A 100-percent consistency in ratings is impossible in any chart because a given connection method may vary widely in workmanship. A low-rated connection, expertly made, will work better than a high-rated, poorly made one. For convenience in using the table, it is assumed that all connections are equally well made in ordinary production facilities by a good manufacturer.

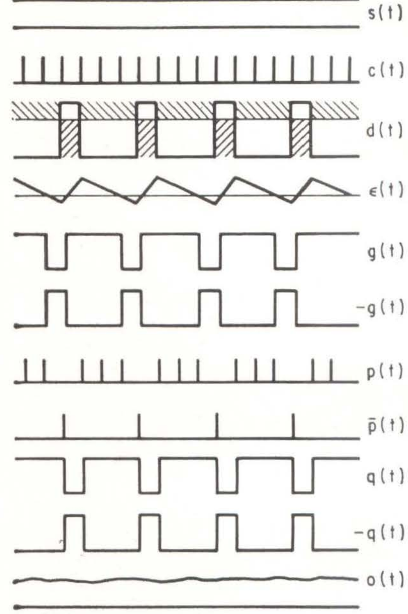
PROS AND CONS

Here are many characteristics of different materials and joining techniques, brought together into one comprehensive table for quick comparison. Cross-checking guides the engineer to the best technique for a particular job

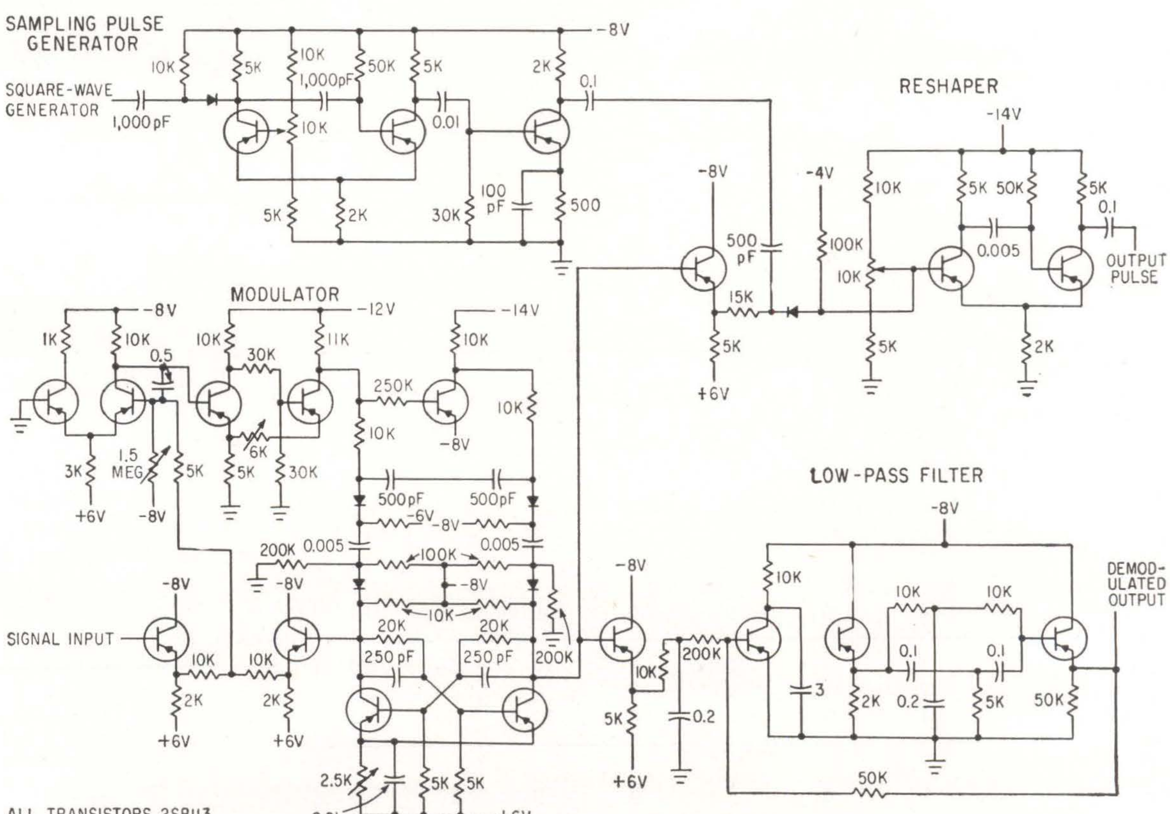
NEW MODULATION TECHNIQUE



PRINCIPLE *of delta-sigma modulator is shown above experimental telemetry modulator—Fig. 1*



OPERATION *of modulator is indicated by key waveforms—Fig. 2*



FLIP-FLOP *set output in experimental equipment is fed to emitter follower and demodulated by low-pass filter. The transmitter has been omitted for simplicity—Fig. 3*

SIMPLIFIES CIRCUITS

Delta-sigma modulation technique permits digital communications systems to transmit signals having a d-c component. Cumulative errors in the demodulated signal resulting from transmission disturbances are avoided, and signal-to-noise ratio is independent of signal frequency

By HIROSHI INOSE, YASUHIKO YASUDA, JUNZO MURAKAMI* and HIROSHI FUJITA*

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THIS MODULATION technique for digital communications systems reduces circuit complexity. Called delta-sigma modulation, it offers d-c transmission capability, stable performance and independence of signal-to-noise ratio from signal frequency. The required bandwidth for the new type modulator is less than for the pulse-number modulation.

Delta modulation has been noted for its circuit simplicity. However, its use has been confined to signals not having a d-c component because of the differentiation and subsequent integration inherent in this modulation. Transmission disturbances result in a cumulative error in the demodulated signal.

PRINCIPLE — The delta-sigma modulation technique was designed to overcome this limitation. Integration takes place in the modulator, so that output pulses carry information corresponding to input signal amplitude.

The delta-sigma modulator is shown at the top of Fig. 1. Output pulse p is fed back to the input and subtracted from input signal s. Difference signal $d = s - p$ is integrated, and integrated difference signal $\epsilon(t) = \int d(t)\,dt$ is compared in amplitude with a predetermined reference. If the integrated difference signal is positive and larger than the reference, the sampling pulse generator feeds a pulse to the output. This negative feedback always keeps the integrated difference signal near the reference. Thus, output pulses carry data corresponding to input amplitude.

Demodulation requires only reshaping of the pulses and passing them through a low-pass filter. No integration is involved, so that no cumulative error resulting from transmission disturbances occurs.

NOISE PERFORMANCE — Theoretical calculations[1] reveal that signal-to-quantizing-noise ratio of the delta-sigma modulation system with single integration is

$$S/N \propto (f_r/f_c)^{3/2} \qquad (1)$$

where f_r is sampling pulse repetition frequency and f_c is cutoff fre-

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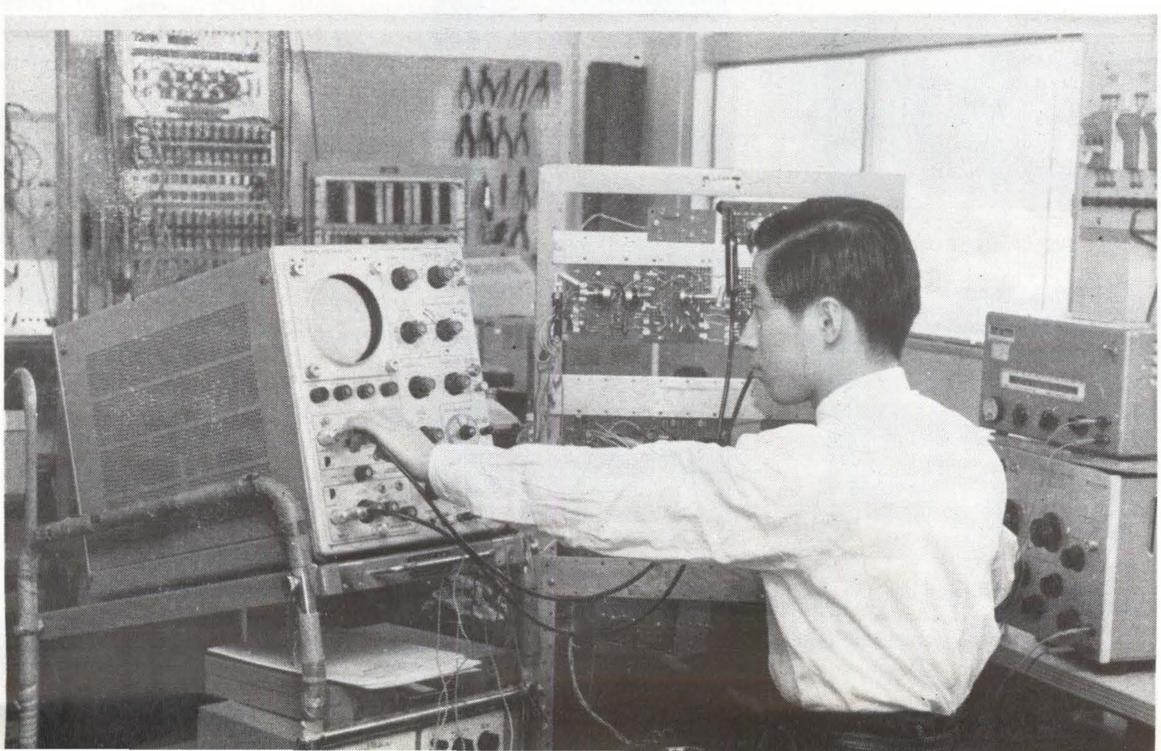
DELTA-SIGMA *modulation technique is tested at Tokyo University by author Inose*



DELTA VERSUS DELTA SIGMA

The lukewarm acceptance of delta modulation is at least partly explained by its performance limitations. Some of these objections may be overcome by this modified delta modulator. The integrator has been removed from the demodulator so that the effect of transmission disturbances on the demodulated signal is not cumulative

quency of the demodulator low-pass filter. Signal quantizing noise ratio the delta modulation system is

$$S/N \propto f_r^{3/2}/f_c^{1/2} f_s \quad (2)$$

where f_s is signal frequency. Eq. 1 and 2 show that the same relationship to the pulse repetition frequency exists for both systems but signal frequency has no relation to signal-to-quantizing-noise ratio in the delta-sigma modulator.

Signal-to-noise ratio of pulse-number modulation is

$$S/N \propto f_r/f_c^{1/2} f^{1/2} \quad (3)$$

where f is sampling frequency. Eq. 1, 2 and 3 indicate that delta and delta-sigma modulation have an advantage over pulse-number modulation in the degree of improvement in noise performance in relation to pulse repetition frequency.

With double integration $\epsilon(t) = \int\int d(t)dtdt$, calculated signal-to-quantizing-noise ratio[3] is proportional to $(f_r)^{5/2}$. For k integrations, signal-to-quantizing-noise ratio is proportional to (f_r) exp $(2k + 1)/2$. Thus, more improvement in signal-to-quantizing-noise ratio is expected with more integration stages.

STABILITY—With signals having a d-c component, drift of the reference level is generally a serious problem. Assuming that the reference level has drifted ϵ' volts, the equivalent variation[1] at the input of the signal integrator is

$$d' \doteq \epsilon'/A \quad (4)$$

where A is integrator gain. Eq. 4 indicates that d' can be reduced by increasing integrator gain. Thus, drift of the reference has only a slight affect on performance.

TEST MODULATOR—The experimental telemetering modulator at the bottom of Fig. 1 was constructed to demonstrate feasibility. Key waveforms are shown in Fig. 2.

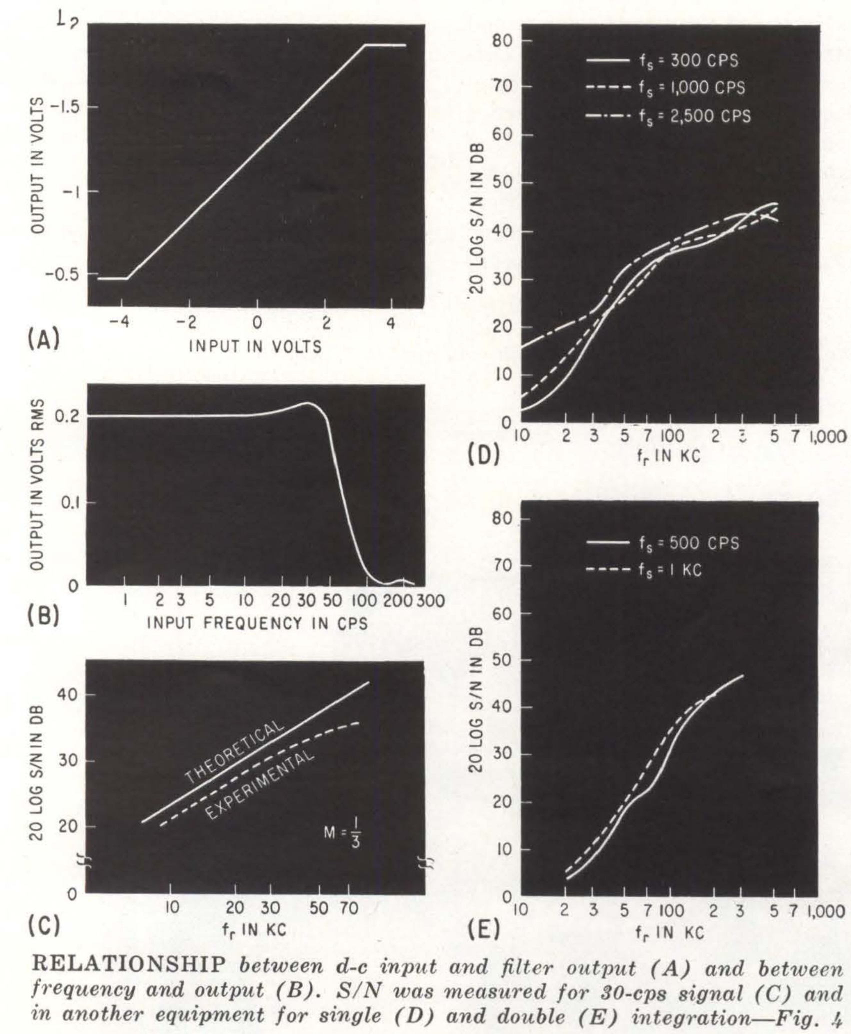
The sampling pulse generator supplies 5-microsecond pulses, c, at repetition frequencies from 1 to 3 Kc. Pulse c is gated by Schmitt trigger output g and $-g$. The gated pulses become set input p and reset input $-p$ of the flip-flop, which reshapes the gated pulse to the width of one sampling period. Reset output $-q$ from the flip-flop is fed back to the input, added to input signal s and fed to the Miller integrator. Integrator output is fed directly to the Schmitt trigger.

When the integrated difference signal fires the Schmitt trigger, the trigger circuit provides positive output g, which opens the gate and passes pulse c to set the flip-flop. When the integrated difference signal is smaller than trigger level, phase inverter output $-g$ becomes positive and resets the flip-flop. Thus, integrator output is kept near the trigger level of the Schmitt trigger. Reset input $-p$ of the flip-flop is fed to the transmitter.

MODULATOR CIRCUIT — The circuit is shown in Fig. 3. The transmitter has been omitted, and the set output of the flip-flop is fed directly to an emitter follower and demodulated by an active low-pass filter with a cutoff of 50 cps.

The relationship between a d-c input to the modulator and output from the demodulating low-pass filter is shown in Fig. 4A for a frequency of 3 Kc and an integrator time constant of 100 milliseconds. This result and repeated counts of the output pulses indicate the satisfactory linearity of the equipment.

Frequency characteristics of the system are shown in Fig. 4B. Since equipment characteristics are iden-



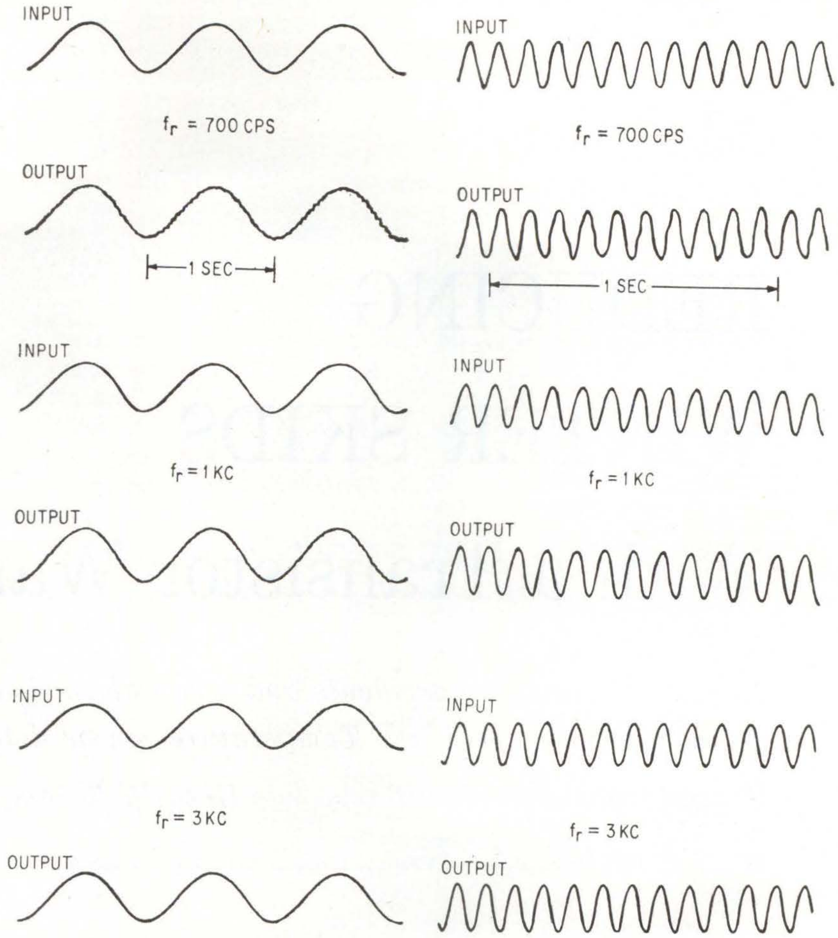
RELATIONSHIP *between d-c input and filter output (A) and between frequency and output (B). S/N was measured for 30-cps signal (C) and in another equipment for single (D) and double (E) integration—Fig. 4* tical to frequency characteristics of the filter, the system has constant characteristics throughout the signal frequency range. Some examples of the input and output waveforms are shown in Fig. 5. The signal-to-noise ratio shown in Fig. 4C was measured at a signal frequency of 30 cps at several repetition frequencies.

Another equipment was designed for a signal frequency range from d-c to 4 Kc and repetition frequencies up to 500 Kc. Measured signal-to-noise ratio with single integration is shown in Fig. 4D and double integration in Fig. 4E. Signal-to-noise ratio is improved about 9 db per octave for single integration and 15 db per octave for double, which conforms with Eq. 1 and 4. Results show that S/N is constant over signal frequency range.

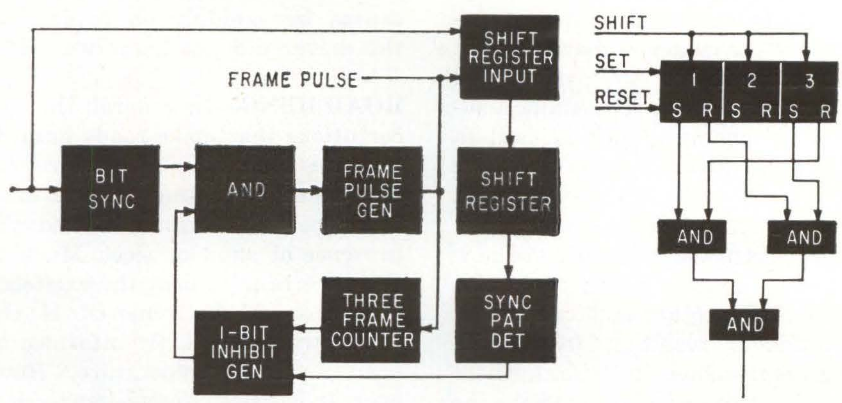
SYNCHRONIZATION—The frame synchronization pattern generally used in digital communications systems is successive ONE's. However, this pattern in the delta-sigma modulation system is vulnerable because the same pattern appears stationary in the signal channel at the edge of the input dynamic range. Similarly, patterns with six or nine bits may appear stationary. Thus a 12-bit pattern was sought that occurs least frequently either stationary or statistically. The pattern is 11001100 . . ., and the equipment in Fig. 6, left, was constructed. Nine channels are for signal and one for synchronization. Frame frequency is 1 Kc.

The frame pulse generator divides the 10-Kc bit pulse by ten to generate the 1-Kc frame pulse. The channel extractor consists of a monostable multivibrator and an AND gate. It extracts one channel out of ten and feeds it to the shift register, which stores three successive bits from the extracted channel. When the required pattern occurs, the shift register stores one of the patterns 110, 100, 001 or 011. Regardless of which pattern is stored set output of the first register and reset output of the third register are identical.

If this relationship is assumed to exist for a stationary pattern of . . . p_j, p_{j+1}, p_{j+2}, p_{j+3} . . ., the relationships $p_j = p_{j+2}$, $p_{j+1} = p_{j+3}$, $p_{j+2} = p_{j+4}$ . . . are satisfied. When p_j and



INPUT *and demodulated output are shown at different signal and repetition frequencies—Fig. 5*



SYNCHRONIZATION *equipment is shown at left of synchronization pattern detector—Fig. 6*

p_{j-1} are determined by these relationships, the pattern becomes unique. Thus, for all combinations of p_j and p_{j-1} (11, 10, 01 and 00, the pattern is uniquely determined to be 11001100. Therefore, the circuit is sufficient to detect the pattern.

The three-frame counter and one-bit inhibit generator detect whether output of the synchronization director is present three frames after operation. If not, a pulse is extracted and the frame pulse is shifted one channel.

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(2) F. de Jager, Delta Modulation—A Method of PCM Transmission Using One Unit Code, *Philips Res Rep*, **7**, p 442.

(3) Y. Yasuda, J. Murakami and H. Inose, Signal to Noise Ratio in Δ-Σ Modulation System, to be published in *1962 Joint Convention Record of Electrical Institutes*, Japan.

(4) Y. Yasuda, H. Fujita and H. Inose, Synchronization in Δ-Σ Modulation, *1962 National Convention Record of Institute of Electrical Communications Engineers of Japan*.

REDUCING WINTER SKIDS

With a Transistor Warning Circuit

AUTOMOTIVE ELECTRONICS

There has been considerable interest in the use of electronic gear in automobiles during the past few years. In practice, however, automotive electronic equipment is still largely limited to the R part of the ever-present optional extras—R & H. Here is a transistor circuit that is actually being used in a few thousand motor vehicles in Britain

Analysis of skidding accidents and study of road icing has led to a warning device for motor vehicles. Temperature sensor determines icing conditions. Simple transistor circuit responds linearly to temperature changes

By J. A. IRVINE, Director, Findlay, Irvine Ltd. Penicuik, England

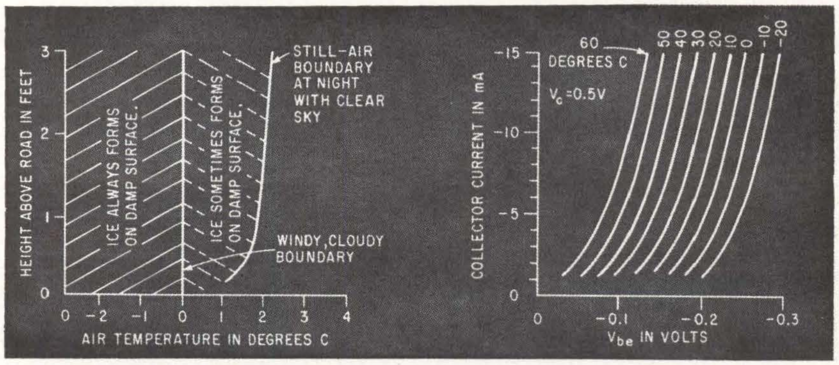
TEMPERATURE sensor with fast thermal response could cut motor vehicle accidents during winter. Operation is based on a linear temperature-dependent characteristic that occurs in both germanium and silicon transistors. The stable temperature-sensing circuit is used in Icelert, an alarm system to warn drivers of conditions under which ice can form on roads. The sensors, several thousand of which are now in use on British roads, could also be adapted to other applications.

Accidents resulting from skidding are notorious in Britain, where temperatures oscillate about the freezing point for several months during the year. Analysis of motor-vehicle accidents during winter indicated that a high percentage are caused by skidding on roads that the driver did not know were icy.

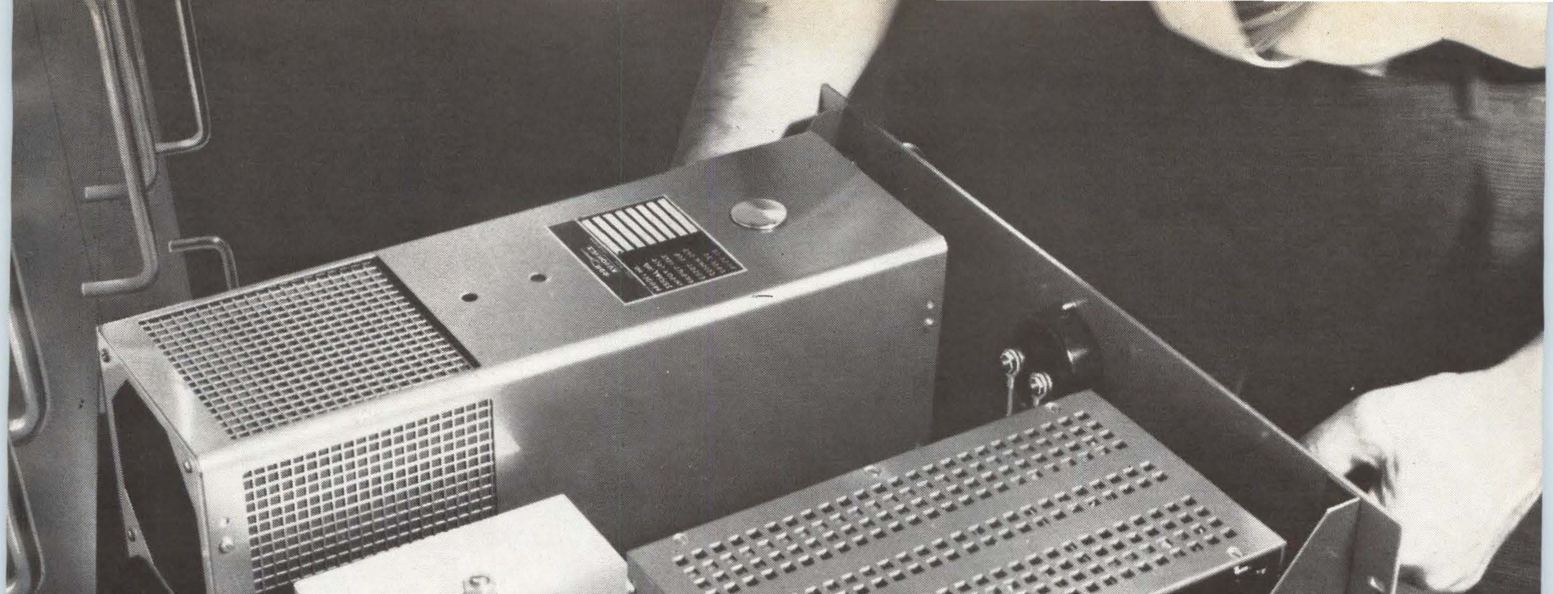
ROAD ICING—In general, the two conditions that make roads hazardous are a moist road surface accompanied by a temperature drop to or below 0 degrees C and the presence of snow or sleet. Much of the uncertainty about the existence of ice would be removed if the driver were constantly informed of road surface temperature. However, it has been found impractical to measure road surace temperature from a moving vehicle.

Analysis of a large number of air-temperature measurements recorded at varying heights above the road during all types of weather indicated a practical solution. If the sky is clear and there is no wind, ice can form on a road when air temperature 2 feet above the surface is 2 degrees C, as indicated at the left of Fig. 1. In some European countries, a freezing road surface is possible at air temperatures of 3 deg. C. This phenomenon results from rapid cooling of the road by radiation and the poor thermal conductivity of air. When it is cloudy and windy, ice forms only when air temperature drops to 0 degrees C. Thus, a temperature-indicating system mounted at the front of the vehicle 2 feet above the ground can enable a driver to assess the likelihood of ice formation.

The system indicates that air temperature has dropped to the



WEATHER *conditions determine air temperature at which ice forms (left). Temperature is measured by its effect on I_c-V_{be} characteristic shown for typical germanium transistor (right)—Fig. 1*



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danger zone by flashing a light within the zone of peripheral vision. Flash frequency is about 2 cps and the mark-to-space ratio changes from 0 to 1 as temperature drops from 2 to 0 degrees C.

SENSING TEMPERATURE — By connecting the junction of a transistor to the case, the transistor becomes an inexpensive and stable temperature sensor with fast thermal response. Most transistor-type temperature-sensitive circuits use the change in collector current with temperature. However, this characteristic has been shown to be unstable with time. A stable temperature-sensing circuit can be based on the fact that base-emitter voltage in both silicon and germanium transistors must be reduced about 2 millivolts per degree C rise in junction temperature to maintain constant collector current.

The I_c-V_{be} characteristic of a typical germanium transistor is shown at the right in Fig. 1. When V_{be} is supplied from a low-impedance source, voltage-temperature characteristic is stable and linear.

OPERATION—Power for the circuit in Fig. 2 is supplied by the vehicle battery. Resistor R_1 and zener diode D_1 provide regulated voltage for the voltage-sensitive part of the circuit.

The temperature-sensing transistor is Q_1, and constant base-emitter potential is provided by the stabilized supply through R_2, R_3 and R_4. Although there is no direct American equivalent to the transistors used, the 2N 466 should be suitable. The effect of temperature on the voltage at the collector of Q_1, which is $| \partial I_{c1}/\partial T_1 | R_6$ volts per degree C, is practically independent of current gain. Any voltage change at the collector of Q_1 is transferred by emitter follower Q_2 to the base of Q_3. Thus collector current in Q_3 changes

$$\beta_3 \, | \partial I_{c1} / \partial T_1 | \, R_6 / (R_{in} + R_7) \text{ amperes per degree C} \qquad (1)$$

where β_3 is common-emitter current gain of Q_3 and R_{in} is input resistance of Q_3.

The indicating lamp is rated at 6 volts and 40 milliamperes. Resistor R_5 is chosen so that Q_3 is saturated by 40 milliamperes of collector current. Because of the nonlinear voltage-current characteristic of the lamp, the saturating current is nearly constant over the range of battery voltage.

To prevent vehicle speed from affecting calibration, the temperature rise of Q_1 from self-heating is restricted to 0.1 degree C by keeping collector current below 400, microamperes. With a zener voltage of 6.5 volts, required collector load is 15,000 ohms. Using this value for R_6, the voltage-temperature relationship at the collector of Q_1 is 0.5 volt per degree C.

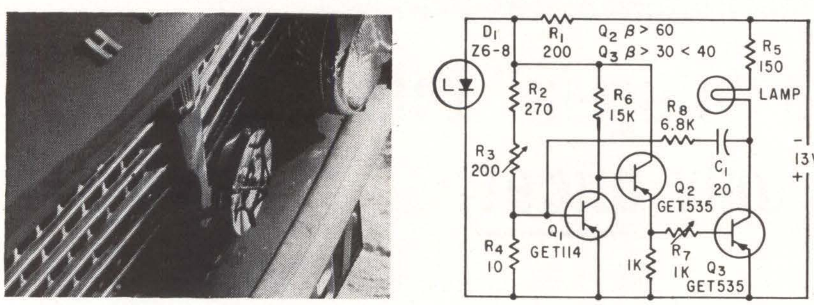
Using a GET 535 transistor for Q_3, current gain is typically 40 and input resistance is about 200 ohms. Substituting these values into Eq. 1 indicates that R_7 should be 800 ohms for current in Q_3 to change 20 milliamperes per degree C. Variations in current gain and input resistance can be corrected by using R_7. With Q_1 in heat sink at 0 deg C, R_3 is adjusted so the lamp is lit but on the verge of flashing. At 2 deg C, R_7 is adjusted so the lamp is out but on the verge of flashing.

Positive feedback from the collector of Q_3 to the base of Q_1 makes the circuit regenerative. However, loop gain is less than unity and no oscillation occurs if Q_3 is either cutoff (junction temperature of Q_1 greater than 2 degrees C) or saturated (junction temperature of Q_1 less than 0 deg C). At temperatures between 2 and 0 deg C, the changes in junction temperature of Q_1 can be regarded as changes in base-emitter voltage with a change of 1 deg C equivalent to 2 millivolts. The variation in V_{be1} with time is shown in Fig. 3A when the junction of Q_1 has reached 2 deg C and R_4 is 10 ohms, C_1 is 20 microfarads and R_8 is 6,800 ohms.

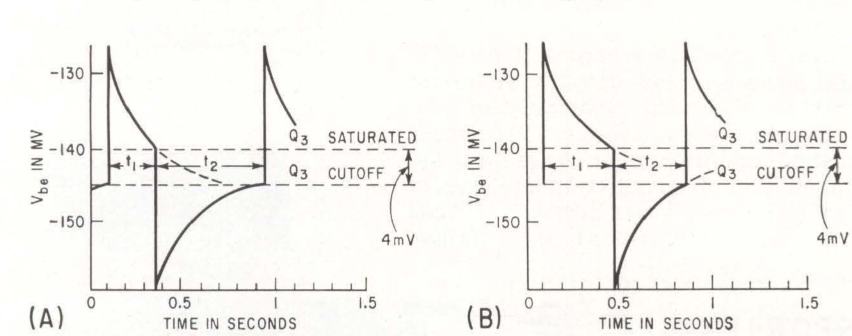
At 2 deg C, Q_3 begins to conduct, and regeneration rapidly causes it to saturate. The positive voltage step that appears at the base of Q_1 is equal to battery voltage $V(R_4/R_8) = 20$ millivolts. Capacitor C_1 then begins to discharge with time constant R_8C_1 toward a potential of -144 millivolts. However, at -140 millivolts, current in Q_3 begins decreasing and regeneration causes Q_3 to be cutoff. The lamp is switched on for time t_1 and off for time t_2.

The variation in V_{be1} with time at 1 deg C is shown in Fig. 3B. Flash duration t_1 has increased because the potential towards which C_1 discharges is -142 millivolts. Duration of the flash increases as temperature approaches 0 deg C, after which the lamp remains on.

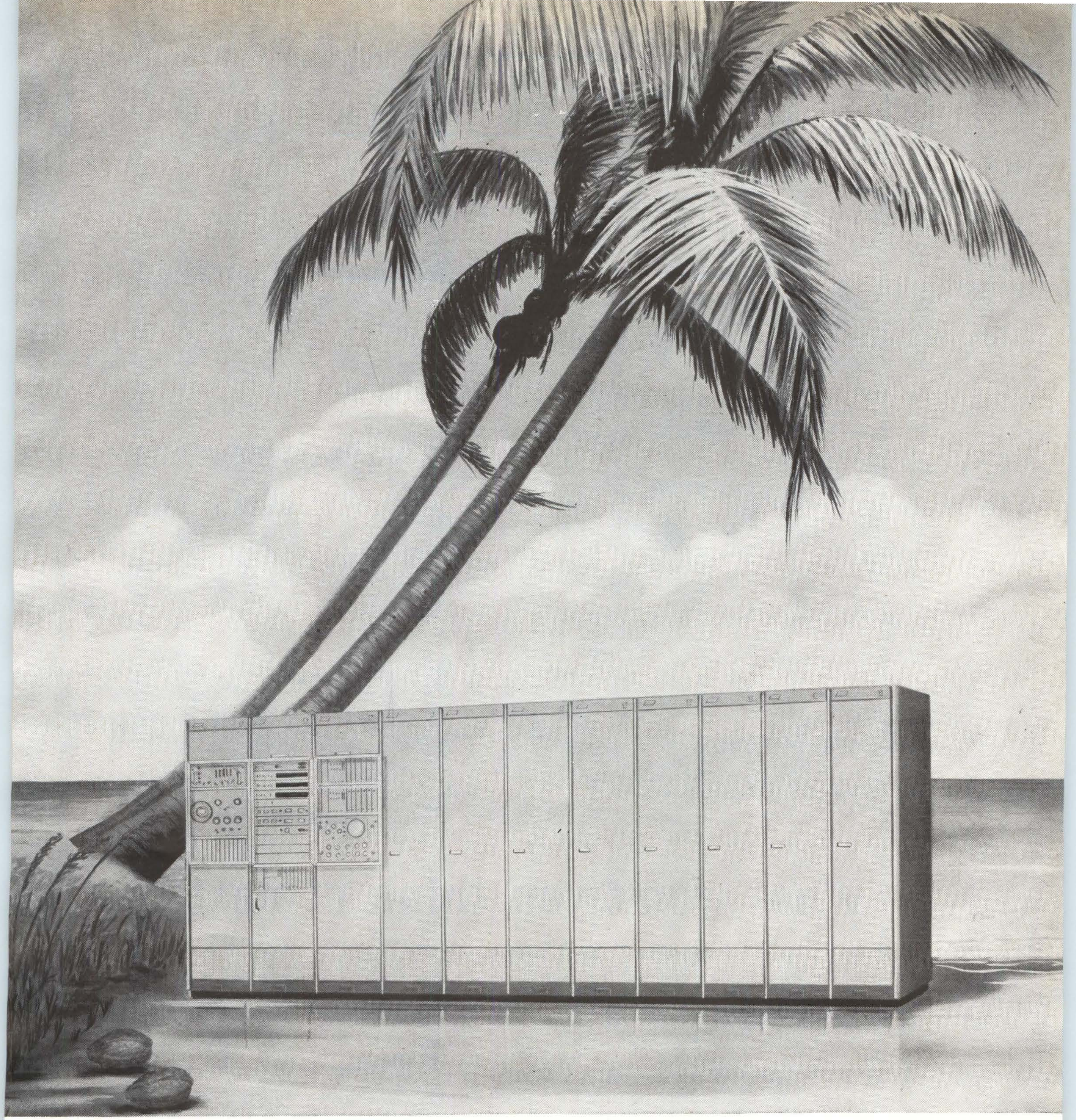
The housing must be waterproof and the components protected from vibration by encapsulating the circuit in a foaming polyurethane.



SENSOR *mounted on vehicle (left) uses transistor circuit (right) to warn drivers of temperatures in the danger zone—Fig. 2*



DURATION *of flash increases as temperature is reduced from 2 to 0 degrees C at heiight of 2 feet above road surface—Fig. 3*



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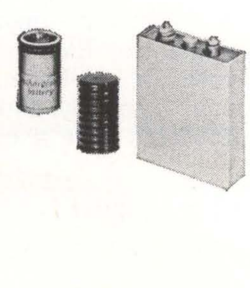

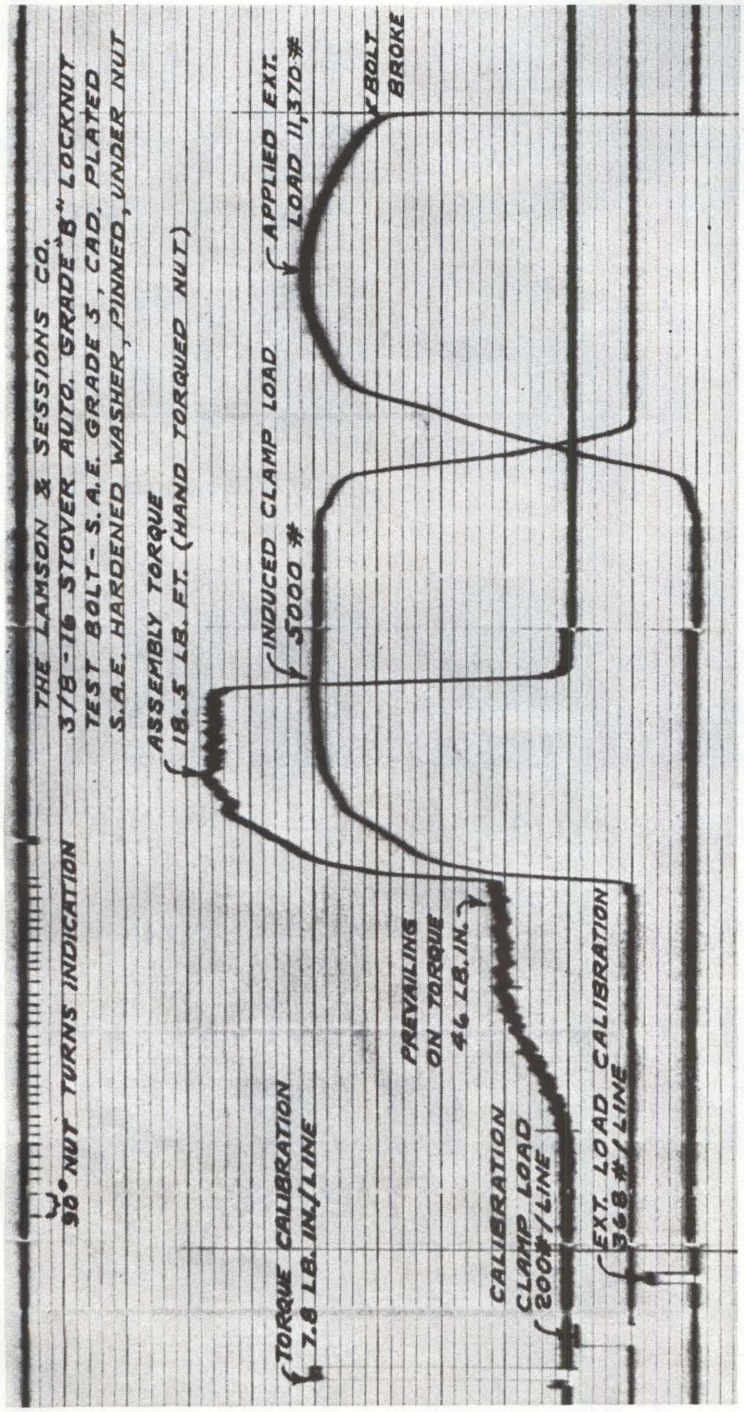

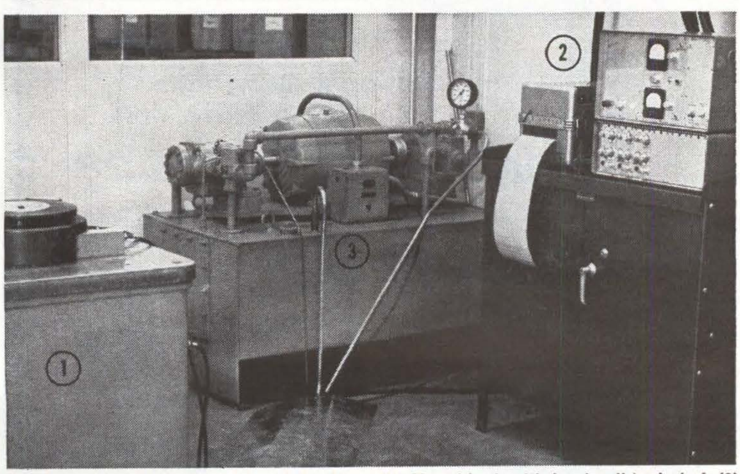

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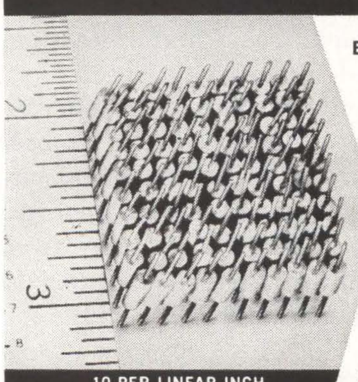

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Magnetic Field Rotates Ultrasonic Waves

New family of devices may be possible, based on recent development

A NEW FAMILY of ultrasonic devices, such as circulators and isolators, now appears possible with a new development announced by Bell Telephone Laboratories. Herbert Matthews and R. Conway LeCraw succeeded in rotating the direction of polarization of a transverse ultrasonic wave, travelling in a crystal, by subjecting it to a d-c magnetic field. The rotation is nonreciprocal, that is, the rotated wave is reflected by the wall of the crystal and returns to its source without returning to its original direction of polarization.

A quartz disk is bonded to one end of a cylinder made of a single crystal of yttrium iron garnet (see the figure), and a d-c magnetic field is applied parallel to the cylinder's axis, thus aligning the magnetic moments of the iron atoms in the garnet in a direction parallel to the field.

Pulsed r-f is applied to the quartz crystal, generating by the piezoelectric effect a 500-Mc ultrasonic wave pulse, polarized parallel to the (100) axis of the quartz crystal. This ultrasonic pulse, travelling down the garnet cylinder, strains the crystal lattice so that the iron atoms are alternately pulled apart from each other and pushed together in a direction perpendicular to the magnetic field.

Straining the atoms creates a second r-f magnetic field, also at the pulse frequency, but perpendicular to the applied d-c magnetic field. A component of the r-f field interacts with the aligned iron atoms and changes the direction of their magnetization. This process is the reverse of magnetostriction, in which ferromagnetic materials such as iron are elongated in the direction of a d-c magnetic field and contract in a direction perpendicular to it.

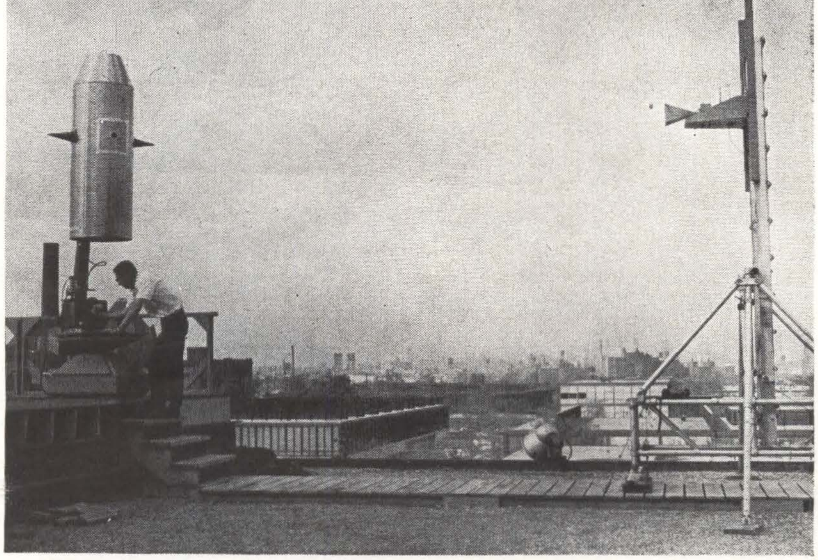
The change in the direction of the magnetic moments of the iron atoms affects the direction in which they move as the ultrasonic pulse strains the crystal lattice. (The motion of the iron atoms is linearly polarized in a plane perpendicular to the wave's direction of travel). The initial group of iron atoms moves up and down in this plane. The next group of atoms moves at an angle to the previous group in the perpendicular plane. This rotation is caused by the interaction of the r-f field and the lined-up iron atoms, and is analogous to the Faraday rotation of electromagnetic waves in ferrites. Each group of atoms is strained at an angle to the previous strain, and thus the direction of motion rotates continuously.

PERMANENT ROTATION—When the wave is reflected at the end of the YIG cylinder, rotation of the strain polarization continues in the original direction, since interaction between strain and the aligned iron atoms is independent of the direction in which the wave travels. The amount of rotation depends on the strength of the d-c field and on the distance the wave travels through it.

Yttrium iron garnet is particularly suitable for this application, because of its extremely high acoustic Q and resulting low loss, and its unique magnetic properties. The high Q enables the ultrasonic wave to make many back-and-forth trips through the crystal and thus undergo considerable rotation before being completely attenuated.

When the pulse reaches the input

Log-Periodic Spiral Antenna for Space



OMNIDIRECTIONAL COVERAGE *and a 2- to 4-Gc frequency range are among the advantages of a new type log-periodic antenna (also see cover) developed by Armour Research Foundation, Chicago, for the Air Force Systems Command's Aeronautical Systems Division. Shown above is a radiation pattern test arrangement, where two antenna elements protrude from a Blue Scout payload nose cone. This series of antennas was developed for measuring electromagnetic radiations in space*

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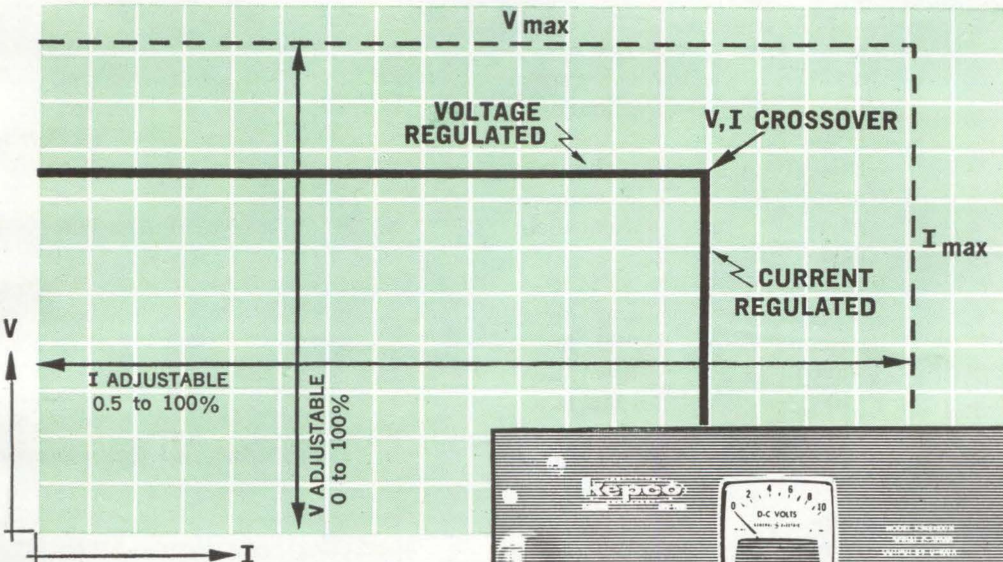

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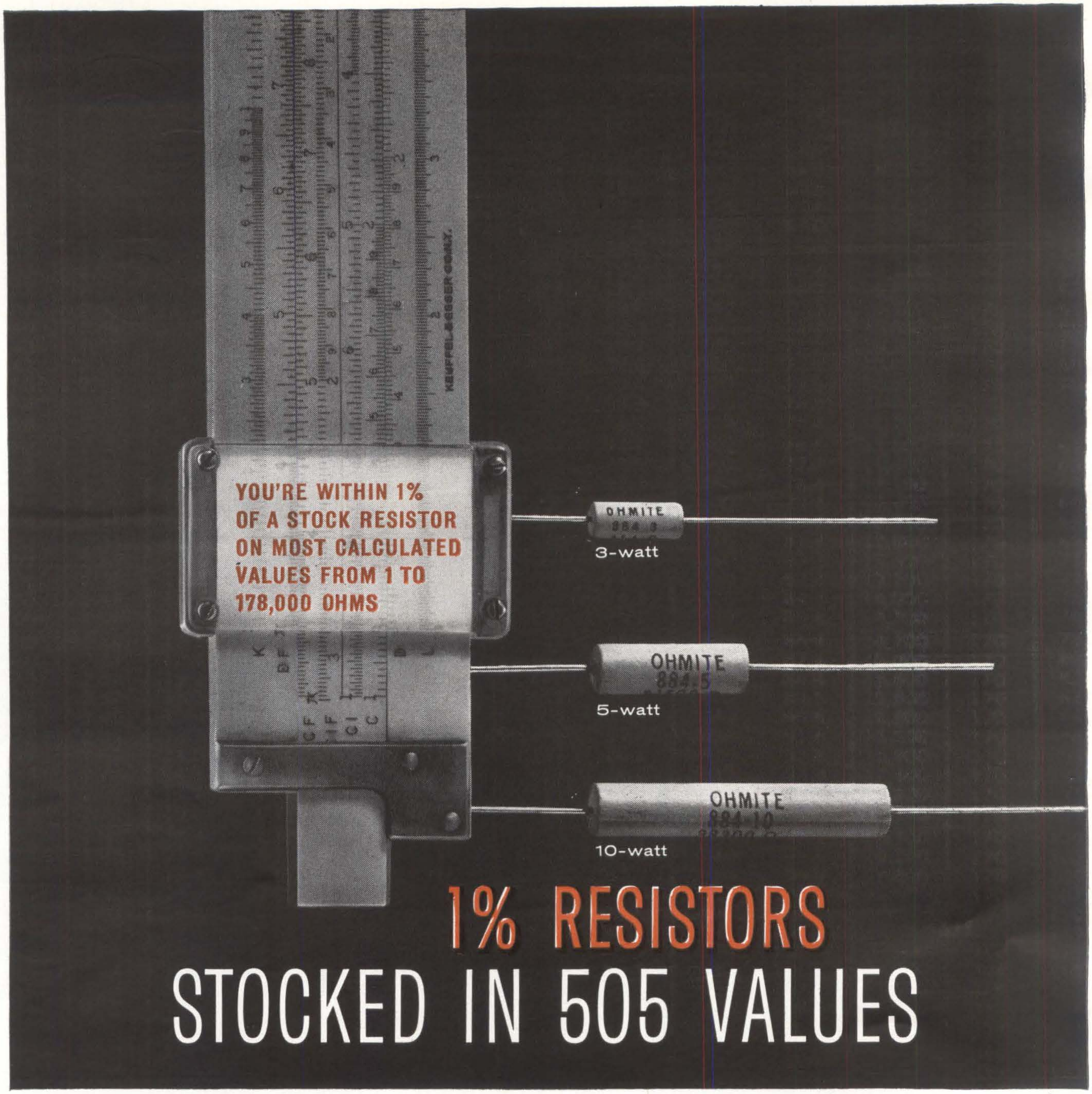
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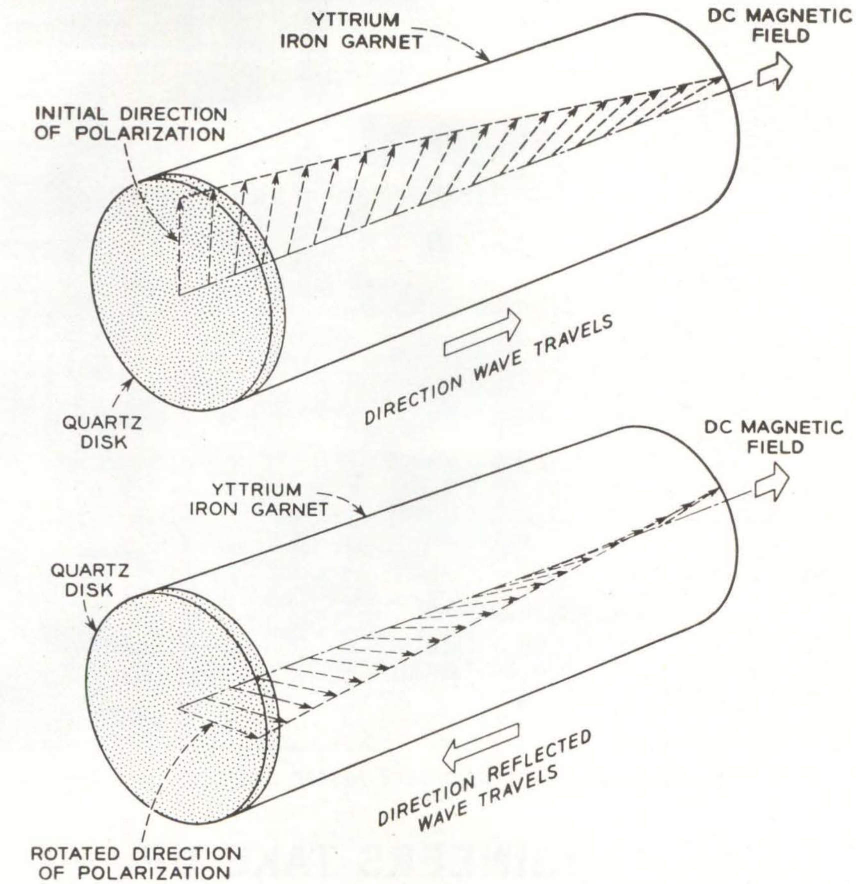


ULTRASONIC WAVE *pulse is launched by quartz transducer, top; as pulse travels down yttrium iron garnet cylinder it interacts with magnetic field and is rotated. Reflected wave pulse, bottom, is further rotated so that wave returns to quartz transducer rotated by a total of 90 degrees*

end of the cylinder, after reflection from the far end, the quartz disk detects only the component of strain along the (100) axis of the crystal; hence the detected amplitude varies as the cosine of the rotation angle. The amount of rotation of polarization is then calculated from the change in amplitude.

Discovery of this effect makes it theoretically possible to build an ultrasonic isolator, which would be used in ultrasonic delay lines to suppress reflections that occur when a wave encounters a discontinuity in a system. Applied to the input of an ultrasonic device, the isolator would rotate the direction of polarization of the wave by 45 degrees when travelling forward, and by another 45 degrees when returning after being reflected. An absorbing device would absorb the energy of waves polarized at 90 degrees, and thus would prevent a reflected wave from reaching the input of a system. At present, however, fabrication is not practical because a suitable absorbing material has not been developed, Bell Telephone Labs said.

Dopplometer Will Measure Ionospheric Absorption

A NEW INSTRUMENT called a dopplometer will be added to the Douglas Geophysical Station at McMurdo Sound, Antarctica. It will be used in conjunction with existing riometers to provide reliable data from the south polar region regarding polar cap absorption events (events caused by the influx of solar flare protons into the polar ionosphere).

The geophysical station now consists of two riometers, operating at 10 Mc and 30 Mc respectively, and a spherics receiver operating at 27 Kc. The riometers measure the absorption of cosmic rays in the ionosphere, which depends on both electron density and collision frequency at the ionospheric height involved; the new dopplometer will measure frequency changes, which depend on electron density only. From simultaneous observations with both instruments it will be possible to determine the collision frequency, the height at which maximum absorption occurs, and the recombination coefficients.

Measuring the ionospheric absorption of high-frequency extraterrestrial radio noise is a useful method for detecting the influx of low-energy solar cosmic rays. The ionization produced by solar protons increases the electron density, so that radio waves passing through the ionosphere are significantly absorbed. Most of this absorption is due to protons with energies of 100 million electron volts or less, which are stopped at heights of 30 kilometers and up. Due to the earth's magnetic field, particles in this energy range reach the earth only in polar regions.

RIOMETER OPERATION — The riometer output, which is a measure of radio-frequency signal strength at a given frequency, is therefore related to the flux of particles that bombard the earth's atmosphere. The riometer measures the low-level signals by using an electronic servo system to adjust a calibrated and metered voltage-controlled reference to an output voltage equal to the signal voltage that appears at the antenna. This antenna signal measurement is independent of the receiver-generated noise.

RIOMETER ANTENNAS — The antenna complex for the present 10-Mc and 30-Mc riometers consists of broad-side arrays, each having two dipole elements side by side with reflectors. The angle of acceptance of each antenna is 60 degrees.

Due to man-made noise in the McMurdo Sound area, the 10-Mc riometer has not produced any useful data; it will therefore be converted to 50-Mc operation.

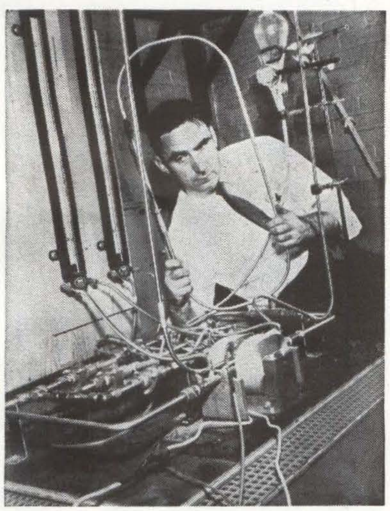
The geophysical station, operated by Douglas in cooperation with the National Science Foundation, is designed to determine the nature and properties of solar flare corpuscular radiation, the effects of the radiation on the earth's atmosphere and the frequency of occurrence of polar cap ionospheric absorption events.

Semiconductor Materials Available for Research

SINGLE-CRYSTAL indium arsenide and single-crystal indium antimonide, produced by the Czochralski method, have been made commercially available as part of Monsanto Chemical's line of III-V intermetallic semiconductor materials.

Indium arsenide is used in Hall generators and photovoltaic cells, and is being tried for possible use in thermistors and magnetoresistance devices. Indium antimonide

Liquid Metal Flywheel



MERCURY, *circulated through stainless steel tube loops by an electromagnetic pump, may help stabilize the attitude of space vehicles. The experimental unit, developed by GE's Advanced Technology Services, is said to have 60 times faster response to directional changes than conventional flywheels, and to be more practical than attitude-stabilizing fuel jets, since it does not require a large fuel supply. The electromagnetic pump used is said to have an efficiency of 30 percent, compared to 1 to 3 percent for conventional magnetic pumps; it uses a lightweight permanent magnet and a low-power flow controller.*

has a primary application as an infrared detector, and its potential applications are in photodiodes and in injection lasers, Monsanto said.

Both materials can be manufactured either undoped or doped.

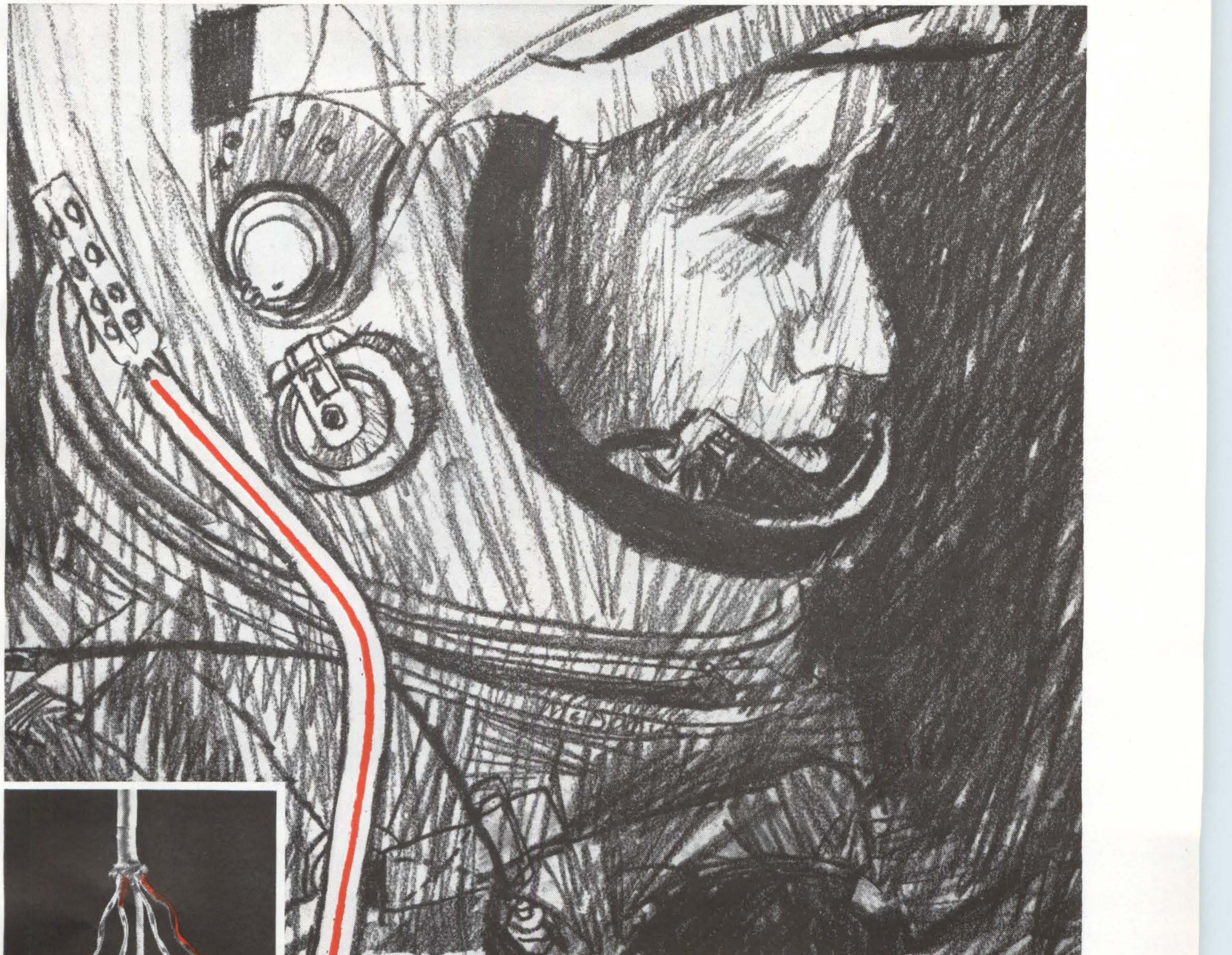
Subsonic Storm Warning

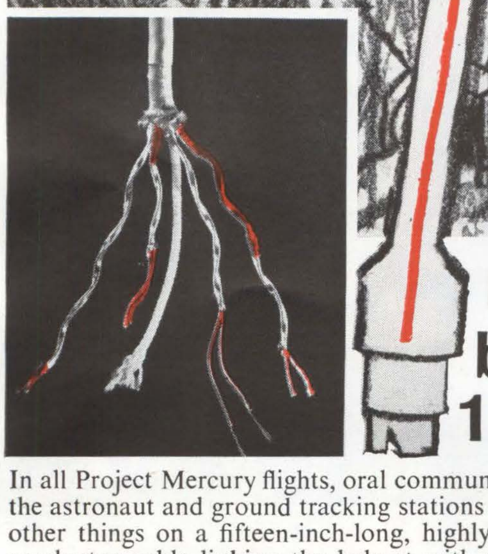
AN INSTRUMENT that gives warning of the approach of a storm 12 to 15 hours before it begins has been developed at the University of Moscow, according to a Russian newspaper.

It has been noted that gulls, dolphins and jellyfish take shelter long before the approach of a storm; they detect the sounds of the storm that arise from the friction of waves against the air. These signals have frequencies of 8 cps to 13 cps. This is detected by the new instrument: a pickup on the deck of a vessel detects the subsonic oscillations and transmits them to an amplifier. The resulting records are said to warn of the approach of a storm and also to indicate its intensity.

Light UV Spectrometer

ULTRAVIOLET *spectrometer undergoing final adjustments before delivery to Princeton University. The 110-lb instrument, built by Perkin-Elmer in Norwalk, will be mounted in Aerobee-Hi nose cone, right, to measure ultraviolet energy emitted by stars*





Ultra-reliable voice link between astronauts and ground: 15" cable insulated with TEFLON®

In all Project Mercury flights, oral communication between the astronaut and ground tracking stations depends among other things on a fifteen-inch-long, highly flexible multiconductor cable linking the helmet with the spacecraft's communications system. The reliability of this cable depends to a large extent on the electrical and mechanical properties of primary insulation and tape jacket of Du Pont TEFLON TFE-fluorocarbon resins. Ten mils of TFE primary insulation are used on each conductor, and TFE tape is used over the shields of two of the twisted pairs. (See photo at left, above.)

Electrically, the superior insulating properties of TEFLON are essential to minimum cross-talk and power loss. Mechanically, the very low coefficient of friction of TEFLON, coupled with good abrasion resistance and miniaturization potential, help provide extreme flexibility—a must for this application. The high-temperature resistance of the primary insulation also makes possible the use of an extremely pliant sheath of silicone rubber, which requires high curing temperatures.

If operational reliability is important in *your* wire and cable applications—and isn't it always?—consider the advantages of TEFLON for insulation. Write to: E. I. du Pont de Nemours & Co. (Inc.), Div. E-1-25-63TE, Room 2526, Nemours Bldg., Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

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TEFLON *is Du Pont's registered trademark for its family of fluorocarbon resins, fibers and films, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.*


What's in it for you?
Just this. This Leach Balanced Armature Relay withstands 2000 foot lbs. of shock loading and 30 G's to 2000 cps vibration to meet Mil-S-901B for equipment-mounted components. How? First, the standard relay has a dynamically balanced armature that provides equalization of the mass to stabilize the contact structure. Next, exclusive buffer blades are added to provide additional stability to the stationary contacts. Finally, the internal mechanism is tied down tight to the enclosure.
But shock and vibration resistance may not be your main aim. Maybe you're looking for minimum voltage spike generation, or radiation resistance, or extended life at maximum rated current, or other special features. This Leach Balanced Armature Relay or one like it will end your search. So stop looking. Start asking Leach for the answers.
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How Diodes Keep Current to Constant Value

Family of current regulators can simplify a variety of circuits

By NEIL WELSH
Chief Engineer
CircuitDyne Corporation
Laguna Beach, California

CONSTANT-CURRENT diodes, called Currectors, are two-terminal solid-state devices that limit current. Current-limiting action of these units is comparable to the voltage-limiting action of zener diodes.

Departure from theoretical behavior of presently available types of Currectors is negligible for most applications. And designers now find their use can effect improvements for power supplies, linear amplifiers, multivibrators, and wave-shaping circuits.

CHARACTERISTICS — Typical first-quadrant characteristic of a polar constant-current diode of this type is shown in Fig. 1A. The operating region, that portion of the curve over which current is essentially independent of voltage, is bounded on its lower side by an abrupt change in slope. A more gradual slope change marks the upper boundary of the operating region.

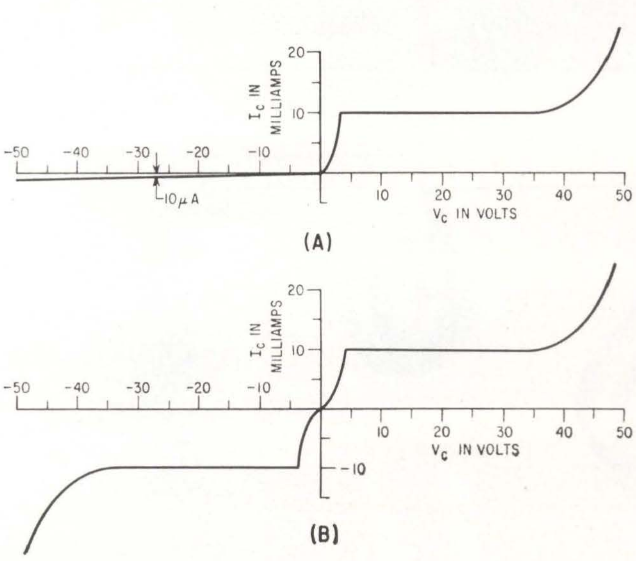
Nonpolar types Fig. 1B, have nearly identical forward and reverse characteristics. Deviations from exact symmetry are slight, and are confined to the extremes of the operating voltage range.

The linear equivalent circuit, Fig. 2, is appropriate to the operating regions of both polar and nonpolar types.

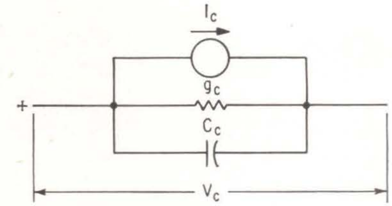
Shunt capacitance, C_c, has a voltage dependence similar to that of reverse-biased *pn* junctions. Magnitude of this shunt capacitance presently limits usefulness of these devices to frequencies below a few hundred kilocycles.

Shunt conductance is also a function of voltage. The peak absolute magnitude of the shunt conductance is held, in most cases, to one micromho per milliampere. However, conductance is negative over much of the operating range, reducing the average value to about one-tenth of the peak. This fact is significant for applications which involve operation over wide voltage spans.

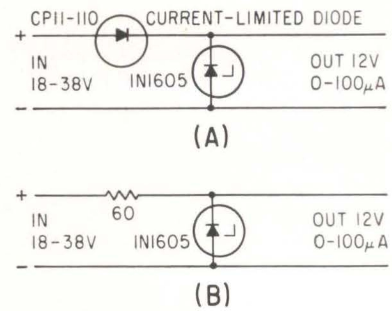
Such an application is the circuit shown in Fig. 3A. This circuit supplies 0-100 ma of load current at a nominal output voltage of 12-v d-c, from a 28 ±10-v d-c source. Currector selected has a current rating 10 percent higher than the maximum normal load current, and functions over extremes of input voltage for both normal and shorted loads. The isolation of output voltage from changes of input voltage varies less than ±4 mv for 16 to 40-v d-c inputs. Short-circuit current is similarly independent of input voltage, being 10 ±2 ma over the full input-voltage span.



TYPICAL *diode characteristics are given for two types of diodes used to regulate current. Curves are shown for polar (A) and nonpolar (B) types —Fig. 1*



EQUIVALENT *circuit is applicable to both types of constant-current diodes—Fig. 2*



CURRENT-LIMITED *shunt-voltage regulator circuits utilizing Currector-zener diode (A) and resistor-zener (B)—Fig. 3*

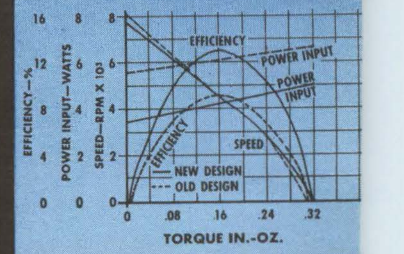
MERITS—Unusual features of this design approach are illustrated by comparison with conventional resistor-zener voltage regulator shown in Fig. 3B.

Largest series resistance that can be used in this circuit is 60 ohms. Output voltage variation, for the rated input-voltage change, is ±425 mv—more than 100 times that of the Currector-zener cir-

Clifton Precision announces 4 major improvements in Servo Motor performance

Greater EFFICIENCY

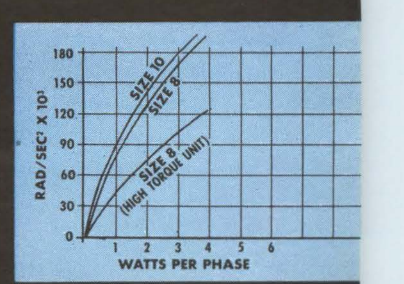
These motors provide more torque for considerably less power input. This results in a more efficient motor as well as a cooler running motor.



Higher TORQUE/INERTIA RATIO

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

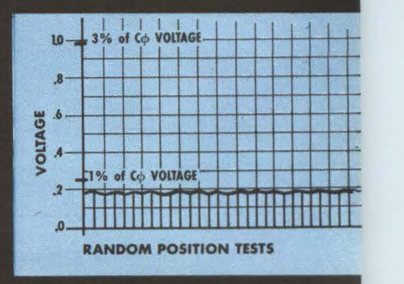
This is such an improvement that in certain motor-generator requirements, a new CPPC servo motor will now suffice.



Lower STARTING VOLTAGE

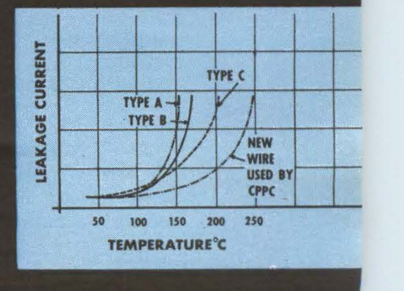
Whereas starting voltages have been specified at 3% of control phase voltage, we can now guarantee 1% and a great deal more uniformity.

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



Less heat vulnerable MATERIALS

New slot and magnet wire insulation allow much less current leakage at high temperatures. In addition, new lubricants and new impregnation enable these motors to withstand 200°C plus. Solderless connections are now incorporated in our servo motor line (all connections are welded).



For full information: Sales Dept. 5050 State Rd., Drexel Hill, Pa. MAdison 2-1000, TWX 215 623-6068—or our Representatives.

Be sure to see and discuss these motors in our suite, Barbizon-Plaza Hotel at the IEEE Convention, New York City, March 25-28.

cppc

CLIFTON PRECISION PRODUCTS CO., INC.

Clifton Heights, Pa.
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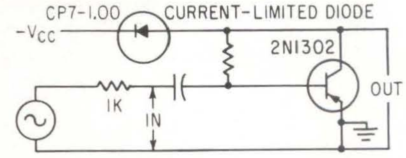
cuit. For normal load conditions, input current varies from 265 ma, at 28-v input, to 435 ma at 38-v input. Maximum zener-diode power dissipation is, therefore, almost four times as high as in the circuit of Fig. 3A. The output impedance of the resistor-zener circuit is about 20 percent lower than that of the Currector-zener circuit, because of the shunting effect of the 60-ohm resistor, and the lowering of the zener-diode impedance due to the higher zener current. Most impedance reduction is due to the latter cause, and so is expensive in terms of efficiency, power dissipation, short circuit-current and input-output isolation. The performance of the Currector-zene r circuit compares favorably with more complex regulator circuits.

TEMPERATURE — Configuration of Fig. 3A, though generally valuable as a zener-drive circuit, has merit for use with temperature-compensated reference diodes, since their high impedance requires that they be driven with a constant current. This circuit is useful also in decoupling applications, for it provides excellent isolation even with a low voltage drop. Also, circuit does not introduce instability caused by the inherent phase shift of r-c decoupling networks.

The Currector in Fig. 4 isolates the output of the single-stage amplifier from changes in supply voltage, and acts as a collector-load impedance. Bias resistor establishes collector voltage at a quiescent value of -10v. With no signal input, collector voltage remains substantially constant for supply voltages between -12 and -35-v d-c. Decoupling, as measured by superimposing 1vrms on a supply of -25-v d-c is 30 db or greater for frequencies below 50 Kc, indicating that a stage of this configuration is unusually immune to power supply ripple and power supply-coupled feedback.

The voltage gain of this circuit is unusually high. Voltage gain in a common emitter amplifier stage approaches r_c/r_b (expressed in T-equivalent parameters) as load admittance approaches zero.

In Fig. 4, the effective load con-



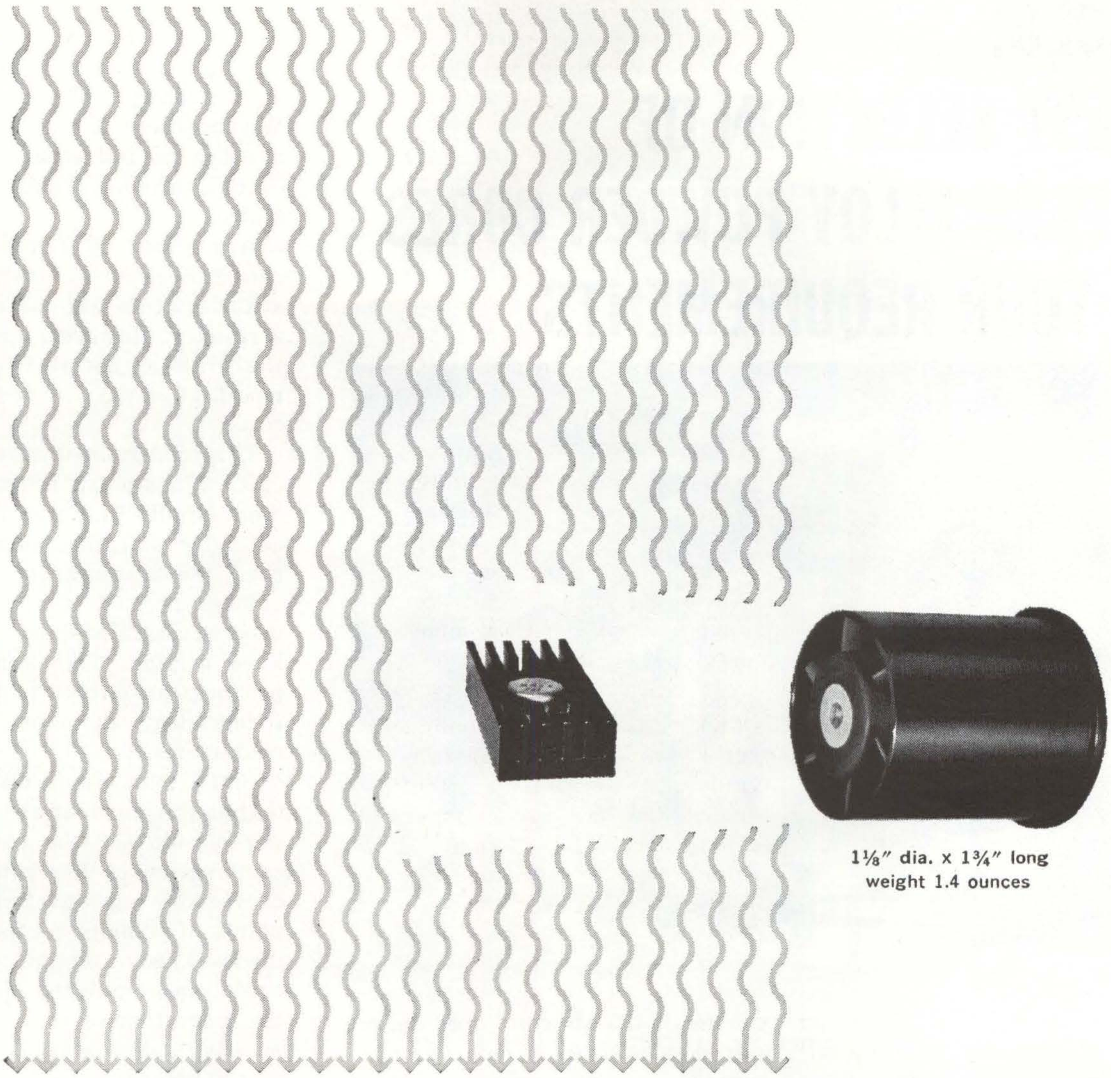
CONSTANT - CURRENT *diode used as a collector load—Fig. 4*

sists of the parallel combination of the Currector shunt admittance and the bias resistance, and is nearly equivalent to the bias resistor alone. Several transistors with betas ranging from 20 to 100, were tried in the circuit. In each case, appropriate bias resistors establish quiescent collector voltage at -10-v d-c. Bias resistor values ranged from 200 kilohms to 1 megohm. Mid-frequency voltage gains for the single stage varied from 57 to 66 db, and upper 3 db cutoff frequencies from 50 to 100 Kc. Low frequency response was limited by the input r-c circuit alone.

As a consequence of the high gain attained by using a Currector as a collector-load impedance, quiescent collector-voltage level must, for linear operation, be defined by feedback. This was the reason for selecting the biasing method used in Fig. 4. Without stabilization of the collector voltage by either internal or external feedback, linear amplification would be impossible. This presents no problem, of course, if operation in the switching mode is desired.

LINEARITY — A simple linear ramp generator utilizes a Currector for linearization. This circuit achieves performance ordinarily obtained only through the use of bootstrap techniques.

When the incoming gate signal turns off the transistor of the generator, Currector current is diverted into charging the capacitor. Rate of change of the capacitor voltage, remains constant until e_c reaches a level such that the voltage drop across the Currector is less than its minimum operating voltage. Thus the lower limit on the supply voltage is defined. Voltage must exceed the desired ramp magnitude by at least the knee voltage of the diode. Also, since the supply voltage is impressed directly across the current limiter when the transistor is gated on, supply volt-

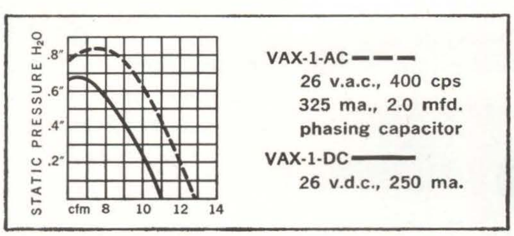


1⅛" dia. x 1¾" long
weight 1.4 ounces

NEW MINIATURE A.C. BLOWER
COOLS CIRCUIT HOT SPOTS

When heat sink techniques won't cool a critical hot spot in your circuit, telephone Globe. New VAX-1-AC blower moves 9 cfm of air against .75" H_2O backpressure. We'll be happy to ship one to you right now. VAX-1 blowers combine the utmost compactness with optimum **useful** performance and good life. If you don't have a.c. available in your circuit, request the d.c. version, also stocked for 24-hour delivery.

VAX-1 blowers are the smallest of Globe's complete line of cooling blowers for electronic applications. Request Bulletin VAX-1 from Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio, Phone 222-3741.



GLOBE

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PRECISION MINIATURE MOTORS, GEARMOTORS, TIMERS, ACTUATORS, CLUTCHES, BLOWERS, MOTORIZED DEVICES age must not exceed the maximum rated voltage of the Currector. Within these limits, supply voltage has no influence on the ramp output, which is both linear and stable.

A number of familiar circuits can be improved substantially by substituting a constant-current diode for a resistor. However, application of the diode is not restricted to the modification of conventional circuits.

In a triangular-wave-shaping circuit, a non-polar constant-current diode limits the magnitude of a capacitor-charging current whenever the instantaneous generator voltage is such that the voltage drop across the diode exceeds its knee voltage. This simple circuit produces an output that is largely independent of input waveform characteristics.

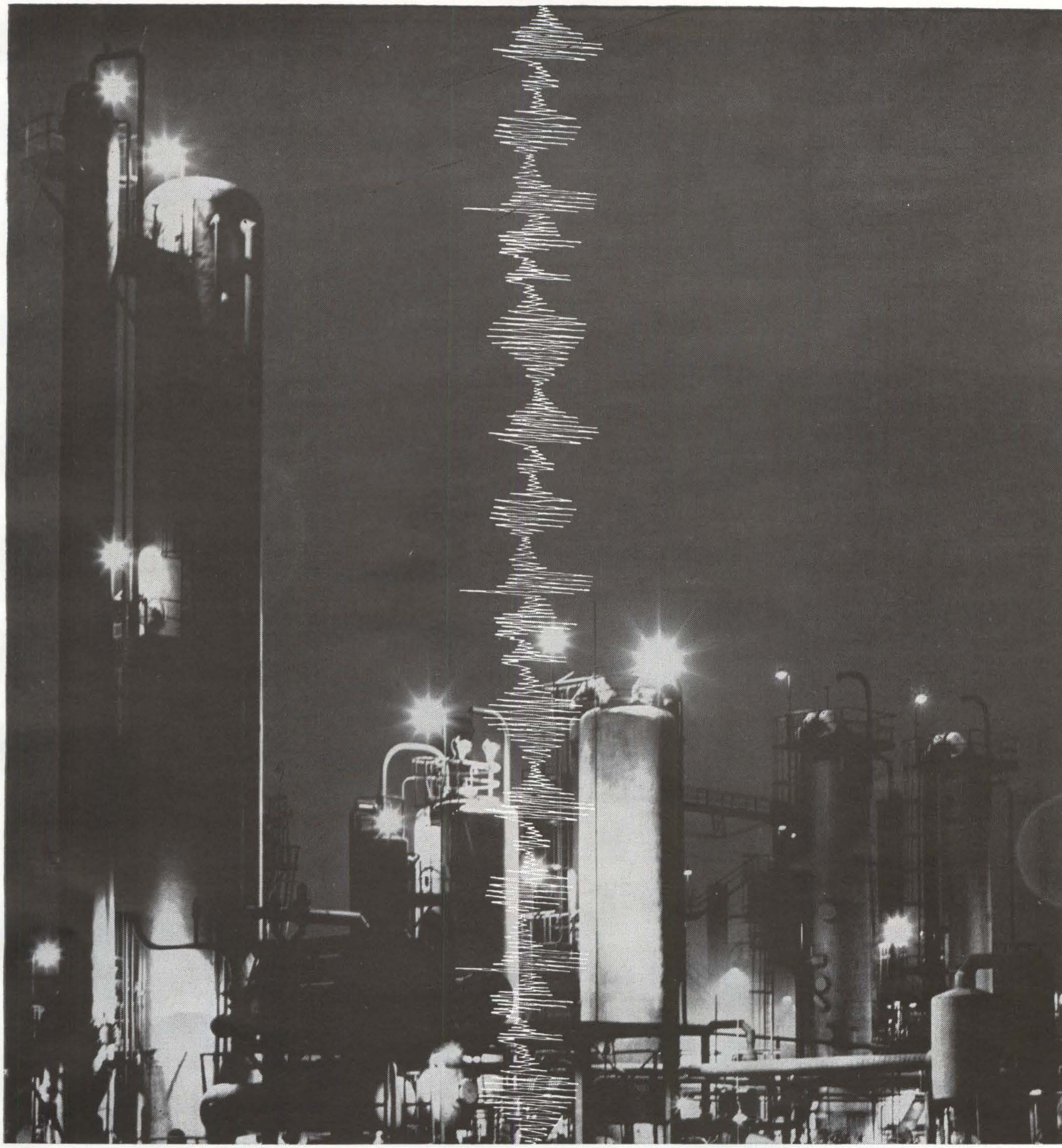
Small truncations visible on the output waveform of the wave-shaping circuit are the result of the combination of low rate-of-change of the driving waveform near its points of polarity reversal, and the diode knee voltage. Truncation error can be reduced by increasing the magnitude of the drive voltage, or using a drive waveform which reverses polarity rapidly, such as a square wave. Similar circuits are easily adapted to the demodulation of pulse frequency, pulse wave and pulse repetition.

High-Temperature Alloy May Fit Microcircuit Needs

A MIDWESTERN copper mill has announced a new coppermetal alloy which possesses moderately high electrical conductivity and is reportedly stronger than copper. The alloy contains 2.3 percent iron and 0.3 percent phosphorus, with the balance copper.

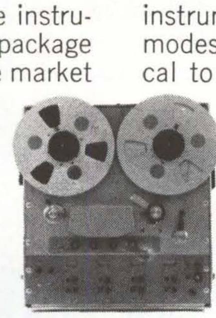
Tensile strength of the alloy in annealed form is 35 percent greater than that of electrolytic copper. Electrical conductivity is 65 percent, compared with electrolytic copper's 100 percent (International Annealed Copper Standard), and this compares with only 28 percent for yellow brass, it is reported.

According to spokesman for



Where can they get a true instrumentation recorder for under $5,000? AMPEX

Now: Ampex offers industry and research true instrumentation performance in a low-cost portable package —the Ampex SP-300. No other recorder on the market does so much for so little cost. The SP-300 gives you four speeds, with electrical switching of both transport and electronics by a single control. It has four channels. Records both FM and Direct. Comes with built-in calibration and erase. And it uses the most thoroughly proved and reliable of all professional tape transports—specifically adapted for precise



instrumentation applications. The price fits the most modest budget: Less than $5,000. And it's economical to operate—uses ¼-inch tape. That's why you'll find the SP-300 perfect for data acquisition needs of medical, industrial and research applications. For more information write the only company providing recorders, tapes and memory devices for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Sales and service engineers throughout the world. AMPEX

Metals Division of Olin Mathieson Chemical Corp, company who developed the new copper base alloy, the Olin 605 HSM copper provides both strength and moderately high conductivity. Also, because of its thermal and electrical conductivity, alloy should solve many problems of excessive heat rise.

Olin Brass has started producing the new alloy in sheet and strip form, and prices quoted are at generally the same level as for company's electrolytic copper sheet and strip.

High-temperature alloy may solve miniaturization problem: maintaining strength and still achieve enough conductivity for small electrical and electronic components.

Current-Carrying Spring Made of Composite Material

MULTITEMPERED composite spring material provides current carrying parts with locking properties at one end and sufficient malleability at the other end for crimping and forming. It is designed for use in

Reliability at 20,000 G's

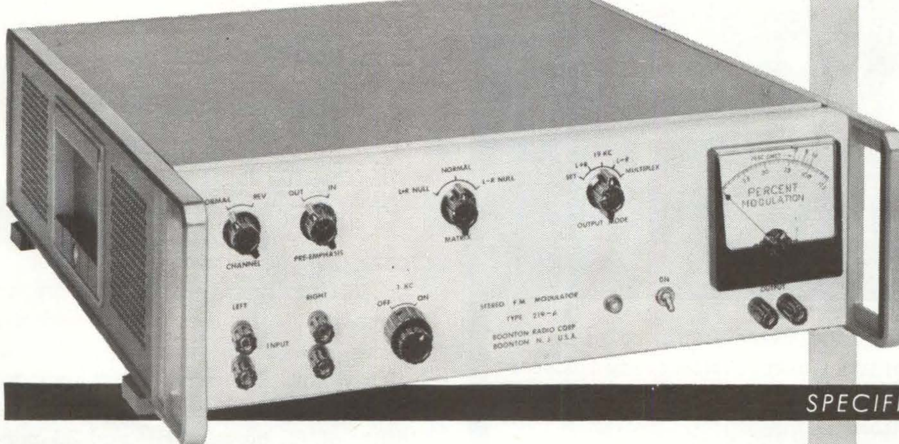
TRANSISTORS, *spinning inside these bins at Raytheon's semiconductor plant, take stresses of 20,000 G's. Units that pass, head for service in Minuteman missile. Normally weighing no more than an ordinary paper clip, a transistor weighs 52 pounds while being tested*

- Direct (L) & (R) Inputs
- SCA Input
- Internal Preemphasis
- Internal 1 KC Modulating Oscillator
- Peak Reading Output Meter
- Self-Checking Switchable Matrix

NEW

FM STEREO MODULATOR

TYPE 219-A



SPECIFICATIONS:

INPUT CHARACTERISTICS

LEFT (L) & RIGHT (R) INPUTS
Frequency Range: 50 cps — 15 KC
Level: 1.7 ± 0.3 volts rms*
*For 45% peak multiplex output; simultaneous (L) and (R) inputs yield 90% peak multiplex output
Preemphasis: 75 μsec preemphasis switchable in or out of circuit

SUBSIDIARY COMMUNICATIONS (SCA) INPUT
Frequency range: 20 — 75 KC
Level: 1.0 volt rms*
*For approx. 10% peak multiplex output

MODULATING OSCILLATOR CHARACTERISTICS

Osc Frequency: 1 KC
Osc Output: Switchable into either (L) or (R) input

OUTPUT CHARACTERISTICS

Level: 0 — 7.5 volts peak*
*Multiplex output
Residual Hum & Noise: > 60 db below 100% output
Crosstalk*: > 40 db below 100% output
*(L — R) into (L + R)

METERING
Range: 0 — 10%* (19 KC and 38 KC only); 0 — 100%*
*Multiplex output; output adjustable 0 — 7.5 volts peak for 100%
Output Modes: Switchable for (L + R), (L — R), 19 KC pilot carrier, 38 KC residual carrier, or multiplex signal

PILOT CARRIER
Frequency: 19 KC
Accuracy: ± 0.01%

MONAURAL (L + R)
Fidelity: 50 cps — 15 KC ± 1 db*
*± 0.2 db and ± 1.5° relative to (L — R)

DOUBLE SIDEBAND SUPPRESSED CARRIER (L — R)
Frequency: 38 KC
Fidelity: 50 cps — 15 KC ± 1 db*
*± 0.2 db and ± 1.5° relative to (L + R)

SUBSIDIARY COMMUNICATIONS (SCA)
Fidelity: 20 — 75 KC ± 0.5 db

OSCILLOSCOPE SYNC SIGNAL
Frequency: 19 KC
Output Level: 0.5 volts rms

Price: **$915.00** F.O.B. Rockaway, N. J.

The FM Stereo Modulator Type 219-A is designed to provide a multiplex output signal in accordance with FCC Docket 13506 when fed with Left (L) and Right (R) audio stereo channel inputs and/or subsidiary communications FM sub-carriers (SCA). The output of the modulator may be switched to provide either (L + R), (L — R), 19 KC pilot carrier, 38 KC residual carrier or the complete multiplex signal which can then be used to modulate a suitable FM Signal Generator. When used with the BRC Type 202-E, no external audio oscillator or other equipment is required.

A peak reading metering system, calibrated in % of system deviation, is provided for setting and monitoring the levels of the individual sub-carriers. The internal matrix may be switched from the normal condition to provide either (L+R) or (L—R) null for checking the matrix in the receiver under test. The modulator is completely self-contained and housed in a single cabinet which may be adapted for standard rack mounting.

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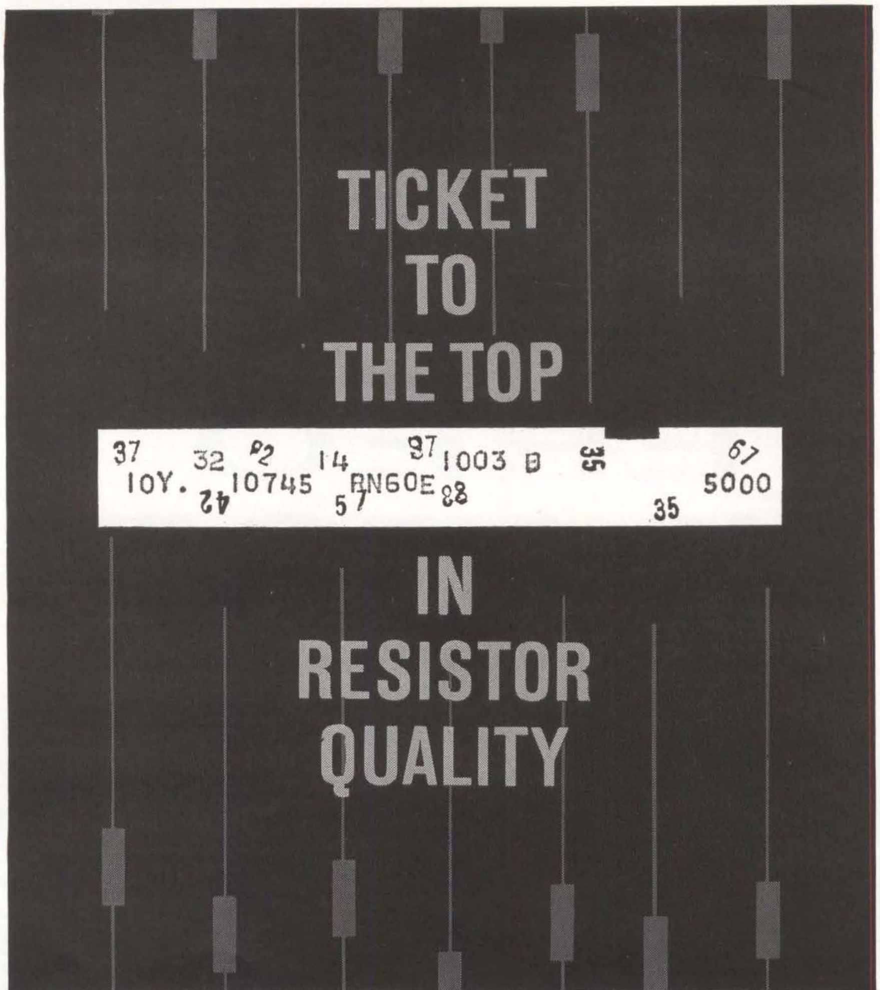
CIRCLE 81 ON READER SERVICE CARD



connectors, clips, springs and terminals.

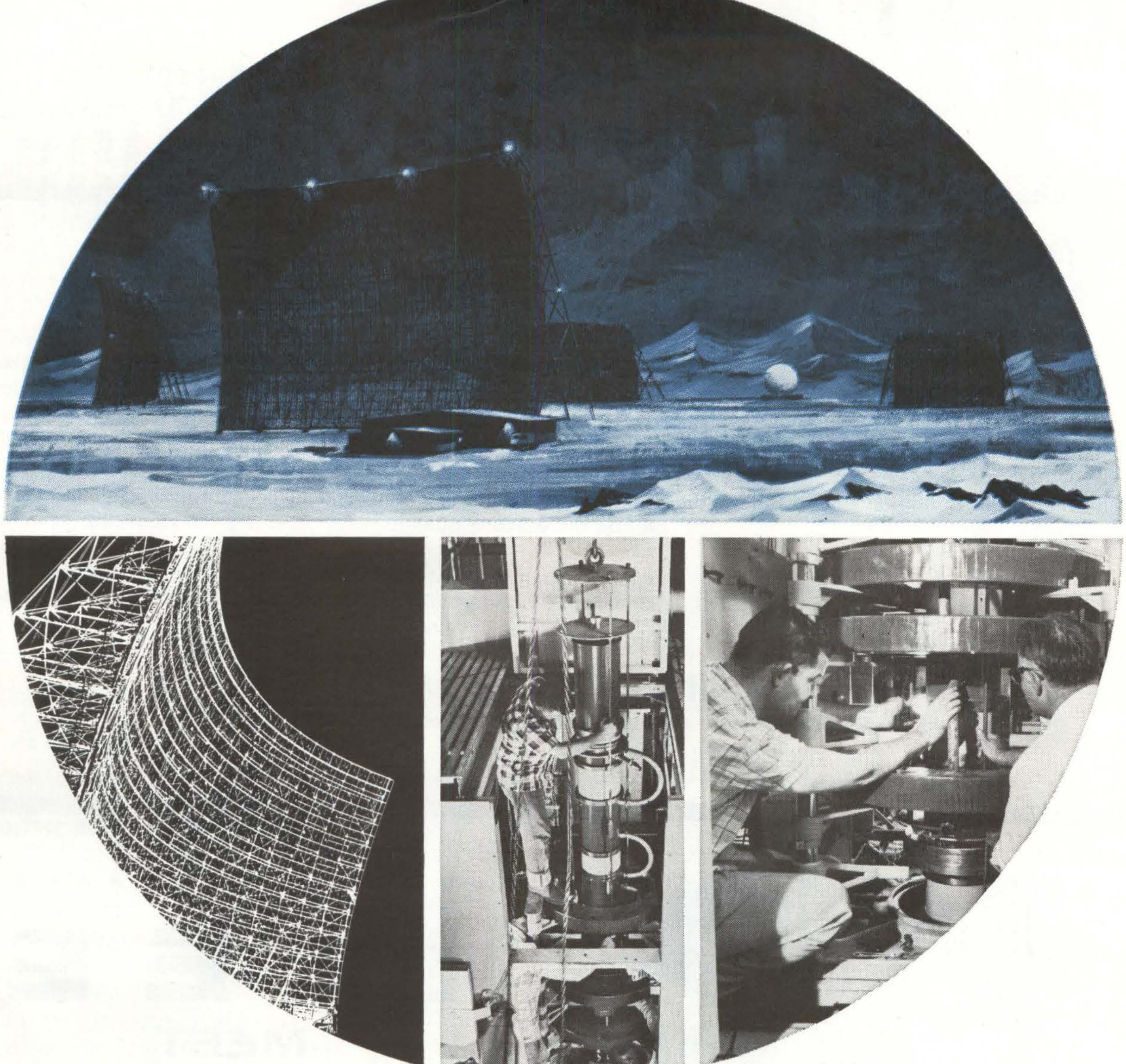
The composite material consists of a layer of carbon spring steel clad on both sides with copper—material ratio of 5/90/5 or 10/80/-10. Metals are metallurgically bonded into one material. Bond is reportedly undamaged by shearing, bending, etc. Supposedly, the composite material provides the high conductivity and low contact resistance of copper with the high elasticity and mechanical strength of spring steel.

Developed by Metals & Controls, Inc., a division of Texas Instruments, it is being marketed under TI's trademark, Conflex. Material is supplied in coils having 4½, 8 or 16 inches inside diameters with strip thicknesses from 0.004 to 0.040 inch and widths ranging from ½ to 2½ inches.

Etchant Established For Tin-Nickel Circuit Boards

GOLD has been used for plating a protective metal over the copper circuit to provide an etch resist when the final circuit pattern is etched out. Recently, a new low-cost plating bath, which plates out an alloy of 65 percent tin and 35 percent nickel by weight, is said to give excellent results when used for a protective overplate.

High reliability, low cost tin-nickel plated circuit boards are etched with ammonium persulfate, according to J. R. Hopkins technical service manager of FMC Corporation's Inorganic Chemical Division. Hopkins told ELECTRONICS that Hewlett-Packard has evaluated several etchants in the developmental stage, and found ammonium persulfate was the best available for the new boards. R. J. Dietz, Hewlett-Packard's printed circuit process engineer, said that the quality of the new boards stems directly from pattern-plating techniques used during their fabrication. Characteristics claimed for tin-nickel plating include improved solderability and lower production costs than gold, as well as excellent wearability, abrasion and corrosion resistance.



SUPER POWER RADAR TRANSMITTERS FOR BMEWS

Continuously scanning the northern approaches to England and North America from installations at Fylingdales Moor, England, Thule, Greenland, and Clear, Alaska, the U. S. Air Force's Ballistic Missile Early Warning System is the free world's first warning of enemy ICBM attack. Continental Electronics has delivered all of the transmitters for surveillance and tracking radars at the three BMEWS installations. ■ Provided under subcontract to General Electric and R.C.A., Continental's AN/FPT-7 super power transmitters use specially-developed klystron tubes to produce multi-megawatt radar signals. Serving what is described by the Air Force as, "the world's most powerful operational radar", the BMEWS transmitters were designed by the specialists in super power transmitting equipment.

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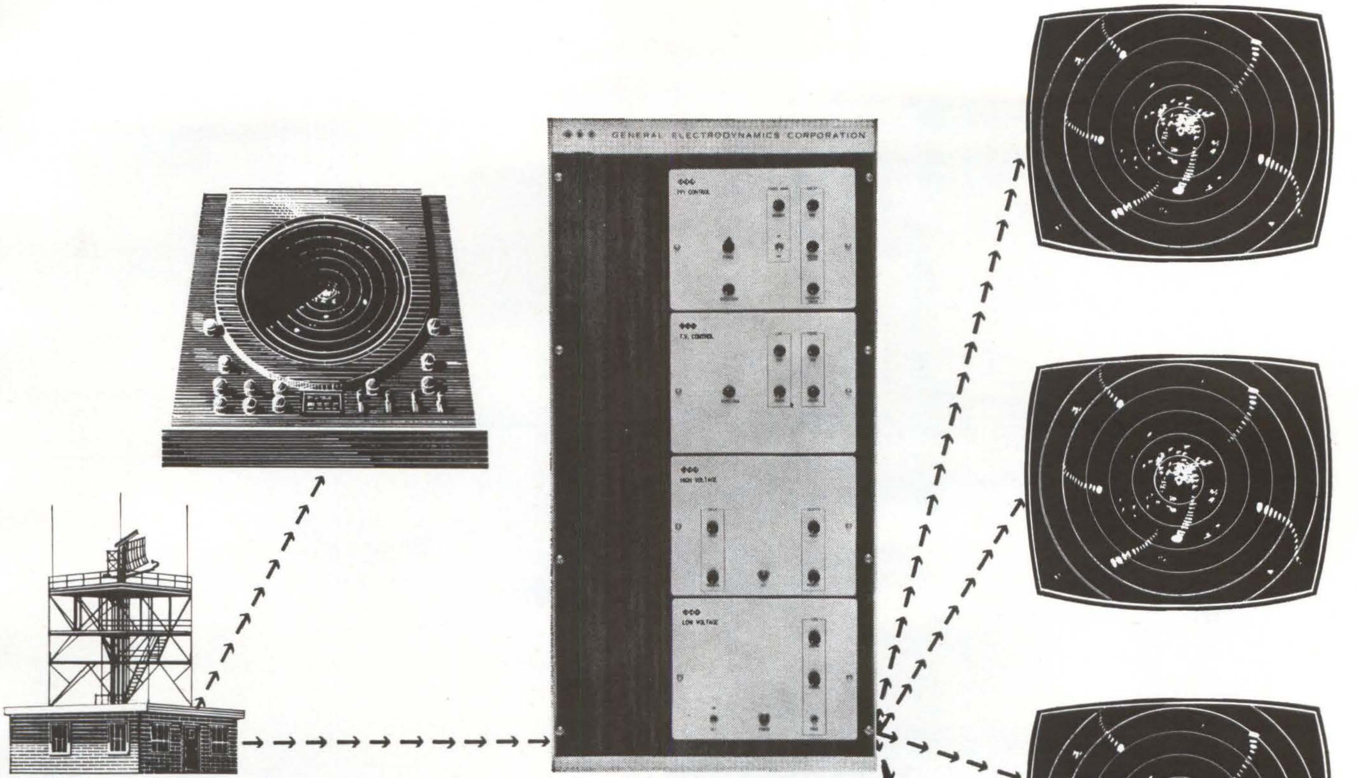
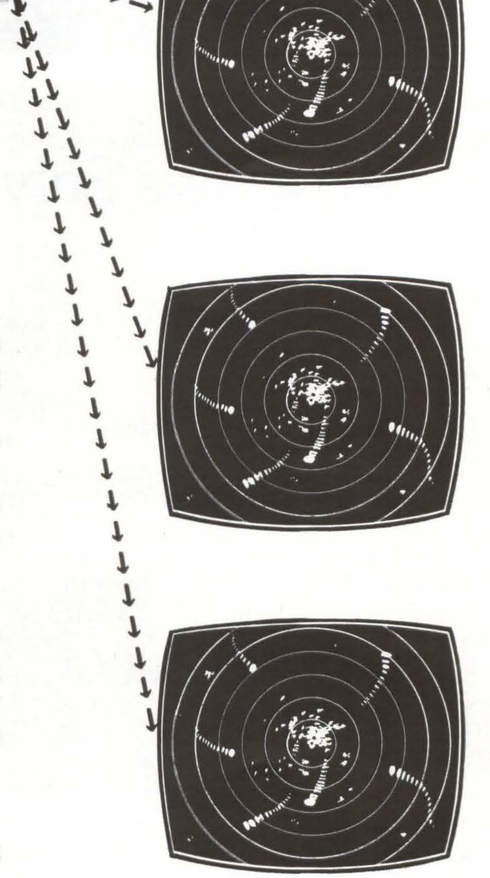
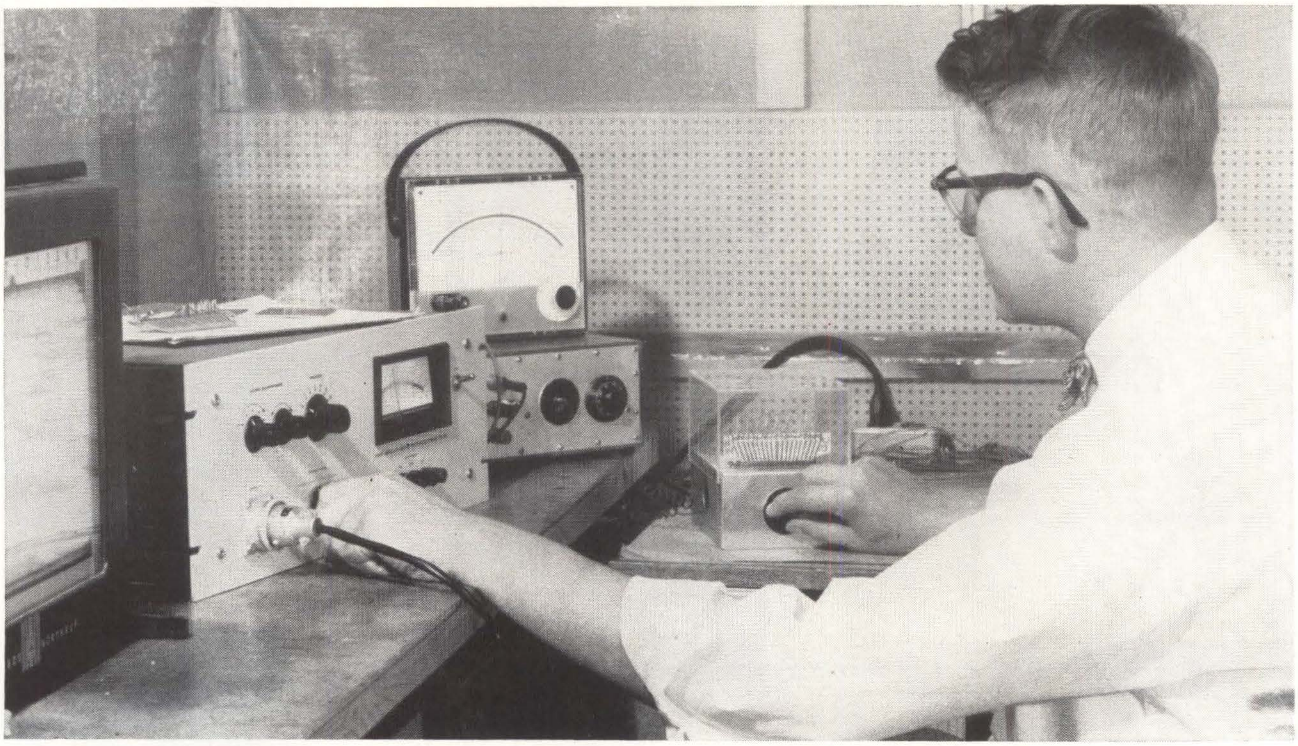

GENERAL ELECTRODYNAMICS CORPORATION





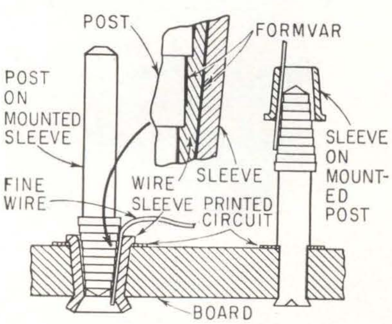
CONTACT RESISTANCE *of serrated connections tested to below 50 micro-ohms*

Serrations Solve Wire-Termination Problem

Permanent, gas-tight, reusable connections made in one step

By MALCOLM N. BROWN
CARL F. VIESER
AMP. Inc.
Harrisburg, Pennsylvania

REMOVAL of the various types of insulation used with fine wire to obtain bare-wire contact is difficult and time consuming. Mechanical stripping calls for extreme care and operator skill. Chemical stripping demands constant alertness. Solder-bath removal has definite difficulties and shortcomings.



RADIAL FORCES *acting on wire in terminal configuration maintain longitudinal, gas-tight, multiple electrical contact in all serrations and adjacent areas—Fig. 1*

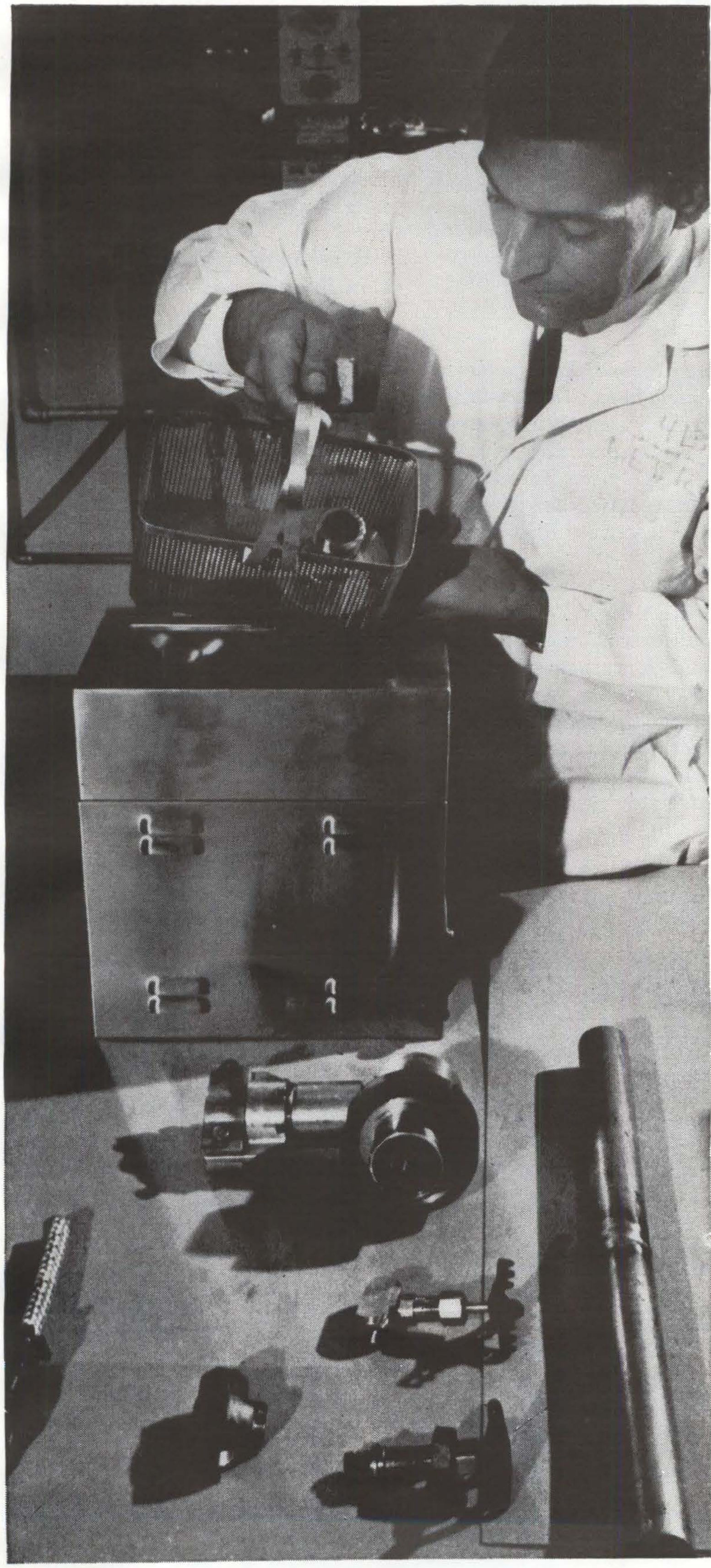
SERRATION TECHNIQUES—At AMP, a one-step termination method not requiring removal of insulation has been developed (Fig. 1). As illustrated, a section of Formvar-coated wire is terminated on a fine-wire post. A series of evenly space concentric serrations, carefully depth-controlled, are machined into the post at a precisely tapered angle. The sleeve has a precisely matched tapered angle so that when it is placed over the post, the insulated fine wire is securely trapped between. A calibrated tool is inserted over the post to drive it carefully into position (or the sleeve may be inserted on a mounted post). The resulting radial forces cause elongation of the wire to produce and maintain longitudinal contact in all serrations and adjacent areas, producing a gas-tight, multiple, electrical contact.

Thus, in a fraction of a second, a fine-wire electrical termination is made that is permanent and gas-tight, but can still be removed and reused, if necessary, up to 5 times. Besides stripping, problems of cold soldered joints, corrosion due to ex-

FINE TERMINATING OF FINE WIRE

Fine-wire terminations in today's miniature and complex circuitry should be: strong as the wire itself, solderless and installed at low cost. Increasing use of fine wire has expanded its categories in a few years from the single No. 28 AWG to No. 26 through No. 56. The technique discussed here has been used with No. 32 through No. 56.

How General Dynamics/Electric Boat precision-cleans missile launching-tube components for Polaris subs!



PROBLEM: Pneumatic launching-tube systems for the Polaris, involving miles of pipes, tees, valves, unions, etc., must be kept scrupulously clean at all times, according to Electric Boat. In an environment of high air pressure, the most minute organic contaminants could support a dangerous explosion. The previous cleaner was rated only 83 to 88% effective in removing a known hydrocarbon contaminant; also it had to be heated to 160°F. before use.

SOLUTION: All launching system components are now cleaned in an ultrasonic bath of FREON fluorocarbon solvent, both initially and during subsequent maintenance. FREON scores 100% every time on the hydrocarbon contaminant test, and works perfectly at ambient temperature.

Electric Boat continues, **"Besides cleaning effectiveness, FREON has high purity, extremely low toxicity, nonflammability and ease of handling. Then, it's noncorrosive to metals and generally inert to plastics and elastomers—so FREON is ideal for cleaning when many different materials of construction are involved. Also, Du Pont supplied us with plenty of research data, which saved us time because we didn't have to run extensive analyses ourselves."**

We'd be happy to show you how FREON can improve your own cleaning operation. First send the coupon or Reader Service Card for our new booklet on cleaning!

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Name__________ Title__________

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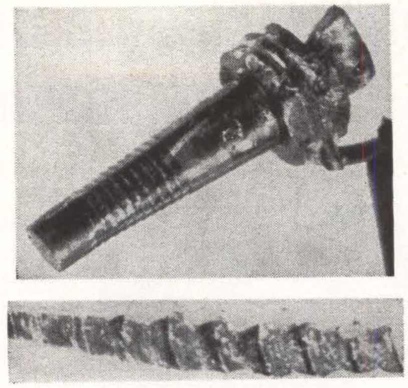
Please send new booklet on FREON solvents for precision cleaning.

I am interested in cleaning__________

☐ I would like Du Pont to send a cleaning specialist.

CIRCLE 87 ON READER SERVICE CARD



BRIGHT STREAK *on terminal post (top) gives evidence of desired cold-welding. Wire (bottom) shows mating streak and multiple areas scrubbed of insulation by serrations—Fig. 2*

cessive fluxing and other soldering problems have been eliminated.

The geometry need not be circular. Experimental fine wire terminations have been formed into square and rectangular configurations and in a variety of other configurations.

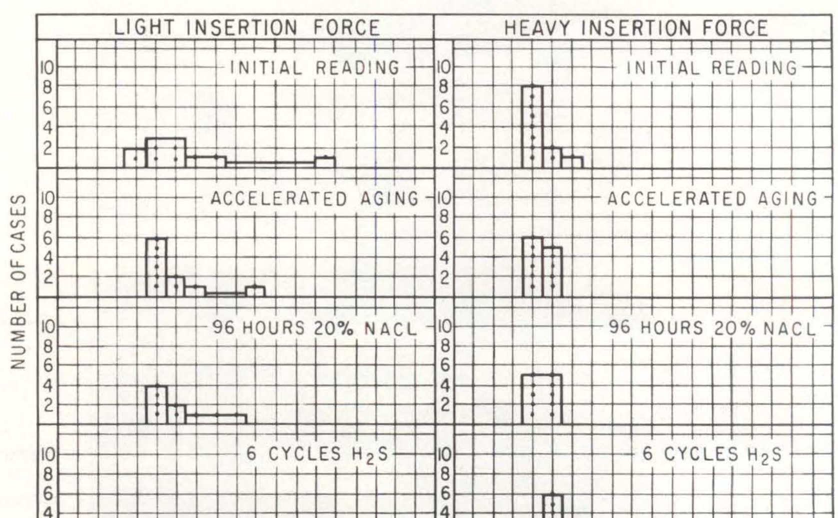
OXIDE REMOVAL—The combination of extrusion, longitudinal motion and serrations thoroughly scrubs away oxides as well as insulation from the conductor to impale the bare conductor on the serration crest. This produces a gas-tight, multiple electrical contact having a high residual holding force. Friction, plus this residual force, lock sleeve and post together with a force of about 8 to 10 pounds.

CONTACT RESISTANCE—The actual contact resistance on all samples tested was well under 1 millohm, with the contact area ranging from 200 to 400 percent of the cross section area of the wire. Contact resistance of many samples with carefully controlled serrations ranged in the neighborhood of 50 microohms or below. Actual cold welding was found to occur during termination process, as shown in Fig. 2. These photographs show a standard Series 53 post and number 32 AWG wire after subjection to a hydrogen sulphide test, disassembly of the sleeve from the post, and peeling of the wire from the post.

Cold welding is indicative of intimate molecular contact and synonymous with the best electrical contact.

PRODUCT TESTING—These terminations were thoroughly tested by the gauntlet of available and applicable military tests, plus several others devised by our engineering department to determine superior capabilities.

The usual Mil-W Specs were followed for thermal shock, vibration,

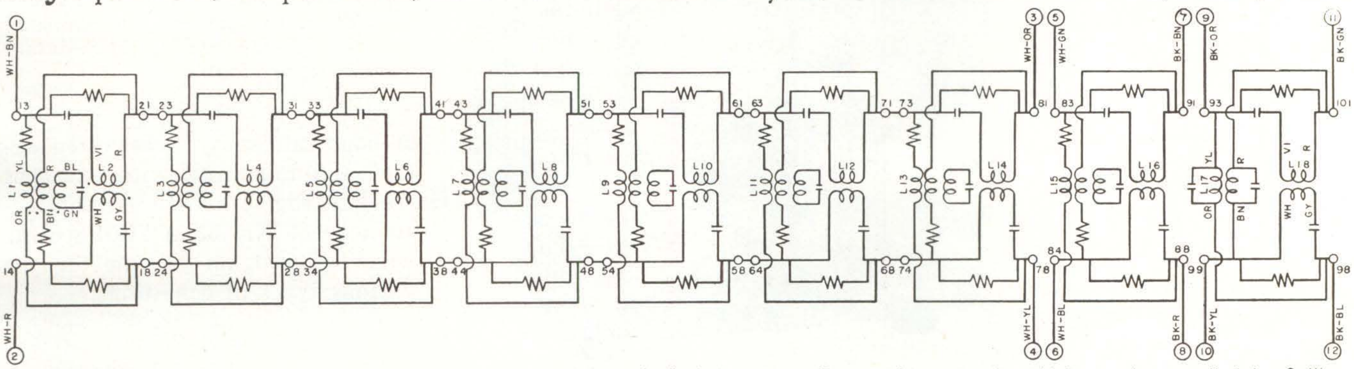


CONTACT RESISTANCE *of copper wire-to-amalgam terminations for various environmental tests—Fig. 3*

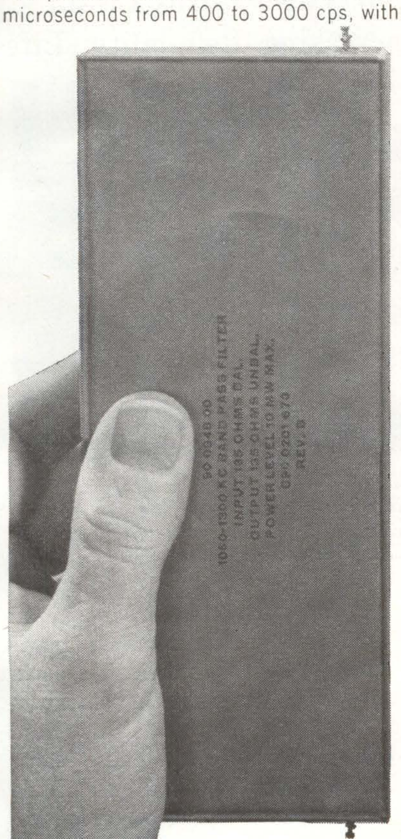
DELAY EQUALIZER

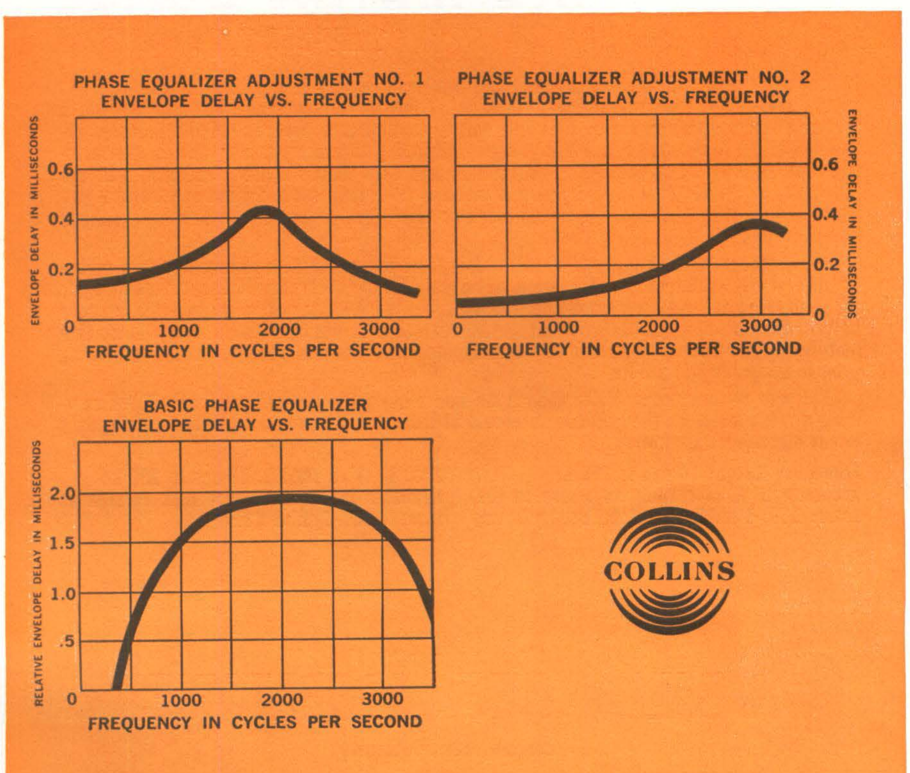
Some are extremely simple, others extremely complex. Collins provides both kinds.

Correcting for envelope delay or delay distortion is becoming more of a problem every day with increased use, complexity and speed of communication and data transmission systems. At today's data transmission speeds, even a very small delay distortion can result in loss of information. □ Developing a network with a precisely controlled phase shift at various frequencies — and without attenuating the signal significantly — requires complex and extensive calculations. This means experience, skill and interest, and on all three counts, Collins is exceptionally well-qualified to develop delay lines, phase equalizers and other complex many-sectioned networks. □ From its own communication systems and from hundreds of government, military and industrial applications, Collins can inject years of experience in network and component design and manufacture into every assignment. Other innovations such as extensive application of computers to network design provides Collins with capabilities far beyond the ordinary. □ Along with this capability to handle the unusual is a broad line of standard toroids, LC filters and other magnetic components. For magnetic components — simple, complex or even not yet developed — Call Collins. □ COLLINS RADIO COMPANY • Components Division • 19700 San Joaquin Road, Newport Beach, California • Phone: KImberly 9-2911 • International Division, Dallas, Texas.

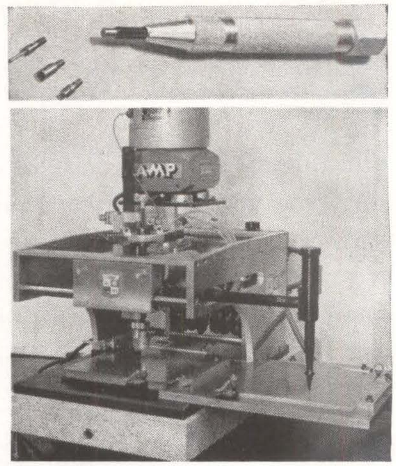


This phase equalizer for a microwave communication system is typical of the unusually complex networks which can be supplied by Collins Components Division. This particular unit contained nine sections plus two adjustment sections and provided an envelope delay of ±150 microseconds from 400 to 3000 cps, with a frequency response of .5 db from 200 cps to 4000 cps and a maximum insertion loss of 13 db.





CIRCLE 89 ON READER SERVICE CARD



CONNECTIONS *are made with manual (top) or semi-automated (bottom) tooling. Spring-loading of hand tool provides calibrated driving force needed for proper mating. Automatic operation is preceded by lining-up machine head over post or eyelet with guiding mechanism (right). Foot switch initiates automatic connection*

96-hour salt spray, accelerated aging, and humidity, with excellent results. Fig. 3 shows terminal resistance of No. 38 AWG Formvar wire to amalgam plating for the various types of conditions.

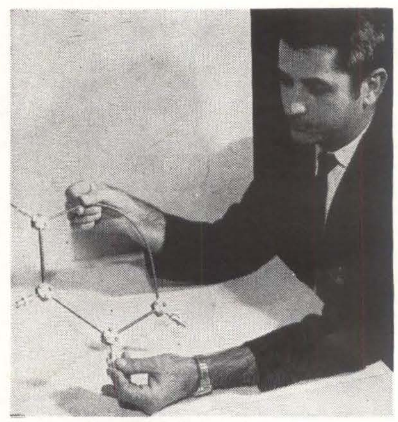
T-W Tubes Really Clean, Increasing Reliability, Life

TECHNICIANS *assemble traveling-wave tubes in GE clean room, claimed to be largest in country devoted to exclusive t-w production*

TRAVELING-WAVE tube production at GE's Palo Alto, California plant is performed in a surgically clean "snow-white" area having an absolute filtering system. Dust and moisture which could cause early failure of tube's anode or cathode are eliminated by the filtering system that reportedly provides a 99.97

percent pure atmosphere. Facilities include: electrostatic floor mat as well as suction vacuum blowers; specially-designed vacuum stations for atmosphere brazing and high-vacuum exhaust of tubes in production; special storage provisions such as vacuum containers for cathodes. GE's Power Tube Department built the facility to increase reliability, life and performance of t-w tubes used in airborne radars and electronic countermeasures systems. It is claimed to exceed conditions specified by the U. S. Air Force for clean rooms. Temperature is held at 72-degrees F ±1 degree and humidity at 40-45 percent. Particles of 0.3 micron in diameter are removed from incoming air.

Custom Hybrid Ring Gives High Signal Isolation



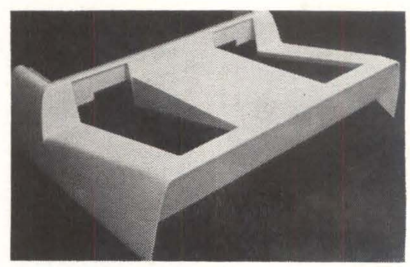
R-F AMPLIFIER *with low power output requirements for Martin's missile systems has its voltage standing wave ratio measured with this special hybrid ring held by its designer, Karl Mitchell*

SIGNAL ISOLATION as high as 50 db is attainable with a hybrid ring designed by Karl Mitchell a foreman at Martin's Orlando Division's Special Program activity. Commercial sources reportedly had said that practical pitfalls prevented realistic production of such rings: (1) costly—$300 per ring; (2) rings with a 40 db isolation must be produced on a cost-plus-fixed fee basis because of the predictability risk. Mitchell built 6 rings initially that, in addition to 50 db isolation, produced a standing wave ratio of 1.1 at tolerances held as closely as ±0.005. Cost was $200 each. Mar-

SPECIAL JIG *is used to assemble rings shown in various fabrication stages*

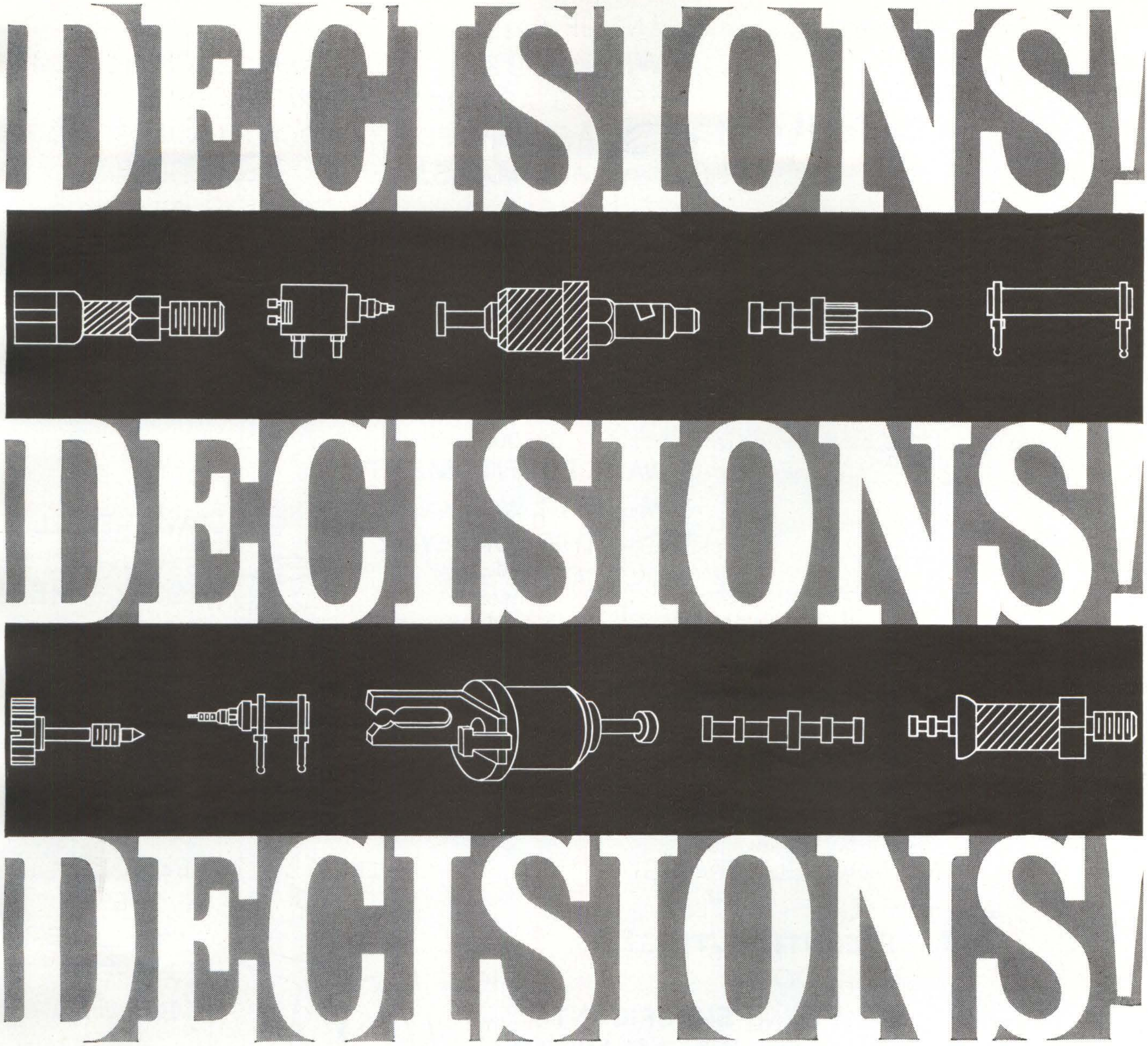
tin is now mass producing rings at lower cost for use as test tools for missile systems. Ring is made of rigid coaxial cable precision cut on a lathe. Special jig used to fit and assemble ring provides the close assembly controls needed.

Plastic Mold Process For Panel Production



BACK-DRAFTED *contours were attained by new process for this ⅛-inch epoxy-reinforced fiberglass cover for a document-processing system*

CUSTOM MOLDING and reinforced plastic laminations have found increased utility in back-drafted contours in new technique by Plastics Div. of Basic Industries, Inc. Process uses epoxy resin rather than polyester. Reportedly this provides advantages: eliminates distortion and telegraphing of reinforcement onto the part face; shape maintained by reducing shrinkage; thickness closely held; no extra reinforcing required; material is self-extinguishing; parts can be color impregnated to restore appearance if damaged; surface can be textured.



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There are more than 15,000 *standard* electronic components in the CAMBION line, including terminals, terminal boards, insulated terminals, coil forms, coils, capacitors, connectors, chokes, computer components and hardware. They are immediately available from stock and so reliable, they are unconditionally guaranteed in any quantity. When it's time to decide, choose CAMBION. You can't go wrong. *Write for our new full-line Catalog.* Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass.

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HIGH GAIN I.F. PENTODES

When improved i.f. performance is required, the first choice of television designers is the EF183, EF184 combination. In i.f. amplifier circuits the frame-grid construction of these two tubes gives outstanding advantages of reduced microphonics, uniformity, better controlled characteristics and high gain—twice the slope of conventional tubes. Both tubes are available with 6·3V, 0·45A or 0·6A heater ratings. For full technical data on the EF183 and EF184, write to the address below.

CHARACTERISTICS

EF183

gm	14	12·5	10·6	mA/V
E_b	170	200	230	V
E_{c2}	90	90	90	V
I_b	14	12	10·5	mA
E_{cl}	−1·8	−2·0	−2·1	V

EF184

gm	15·6	15	mA/V
E_b	170	200	V
E_{c2}	170	200	V
I_b	10	10	mA
E_{cl}	−2·0	−2·5	V

Full details on the Mullard range of tubes for television, stereo and high-fidelity available from:

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81 SPRING STREET, NEW YORK 12, N.Y.
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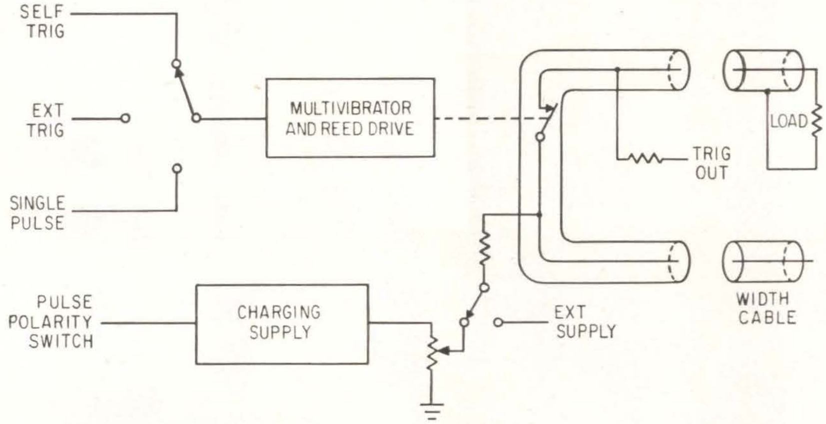
CIRCLE 97 ON READER SERVICE CARD

Generating 0.5-ns Risetime Pulses



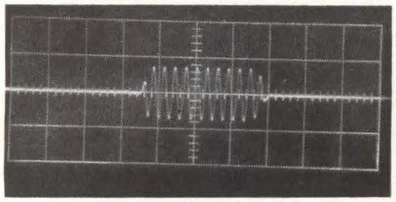
Coaxial-cable shaper produces variable width and amplitude ns pulses

RECENTLY introduced by Spencer-Kennedy Laboratories, Inc., 1320 Soldiers Field Road, Boston 35, Massachusetts, the model 503A fast-rise pulse generator is designed to test transient response of wide-band systems used in radar, communications and nuclear research. The variable repetition rate is from 50 to 120 pulses per second which can be extended to 0 to 120 pps with an external source. Rise time is less than 0.5 nanosecond, amplitude is variable from 0 to 150 v, or up to 1 Kv with external supply, and the device has six built-in pulse widths of 1, 2, 10, 25, 50 and 100 nanoseconds. An external delay line can be added to provide unrestricted maximum width. An output trigger, occurring simultaneously with the main pulse, is available on the front panel. As shown in the sketch, the pulse is generated when the energy stored in a section of coaxial cable, charged to a selected potential, is discharged into the load. When the relay is open, the 50-ohm width cable is charged through a resistor whose value is large compared to cable characteristic impedance. When the relay closes, a voltage step appears at the output. Simultaneously, a voltage step of opposite polarity but equal amplitude travels down the width cable from the switch. Because cable is unterminated, the step is reflected without amplitude or polarity change and cancels the pulse at the output thus creating the pulse trailing edge. Pulse width is determined by length of width cable. The switch is a mercury wetted contact relay.

CIRCLE **301** READER SERVICE CARD

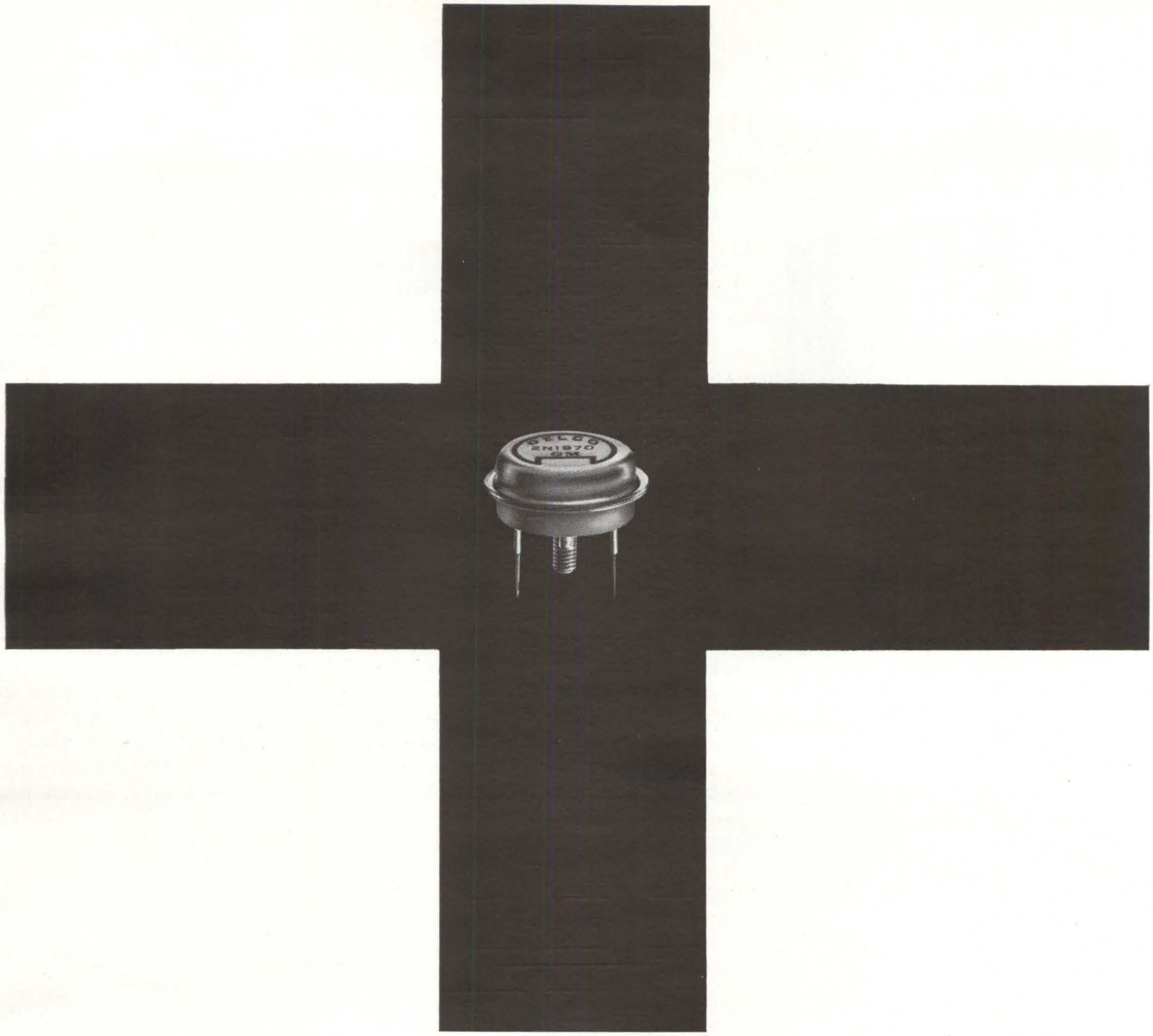
Oscillator Is Powered by Input Trigger

NEW from RHG Electronics Laboratory, Inc., 94 Milbar Boulevard, Farmingdale, New York, the TD series of tunnel-diode oscillators use the input video signal to provide the necessary power to generate r-f pulses at preset frequencies between 10 and 100 Mc. Standby power is zero. Trigger signal is 30 v and output is greater than −30 dbm into a 50-ohm load. Risetime is 2 r-f cycles nominal while a built-in zener regulator prevents frequency and amplitude variations during the pulse period. Output only occurs with trigger application and ringing and overshoot are undetectable. Output frequency can be trimmed when desired. Applications include testing of i-f and logarithmic amplifiers, simulation of fast system pulses, checking transient response of filters and in programmed oscillator applications. Besides individual frequencies, packages containing up to 10 frequencies are available. The photograph shows a typical output waveform. (302)



Microwave Bandpass Filter Is Electronically Tuned

ANNOUNCED by Watkins-Johnson Co., 3333 Hillview Avenue,



Any resemblance to 12 other power transistors is purely economical

Delco Radio's 2N1970 is a high-amp., low-gain, high-voltage, low-cost power transistor that you can substitute for any of 12 other higher priced power transistors.

The 2N1970 can directly replace the 2N442, 2N443, 2N2077, or 2N2490—at a cost savings!

With minor circuit modifications, the 2N1970 can also replace the 2N2075, 2N2076, 2N2080, 2N2081, 2N173, 2N174, 2N278, or 2N2491—at a cost savings!

Reduce production cost without sacrificing product quality. Place your order for Delco's 2N1970 at one of our Sales Offices listed below. Or phone your nearby Delco Radio Semiconductor Distributor.

Ic (MAX.)	Vcbo (MAX.)	Vebo (MAX.)	Vceo (MAX.)	Sat. Voltage @ Ic (MAX.)	Gain Min./Max. @ Ic	Thermal Resistance (MAX.)
15A	100V	40V	50V	1.0V @ 12A	17/40 @ 5A	.5° C/watt

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MUrdock 7-3770
AREA CODE 201

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560
AREA CODE 313

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807
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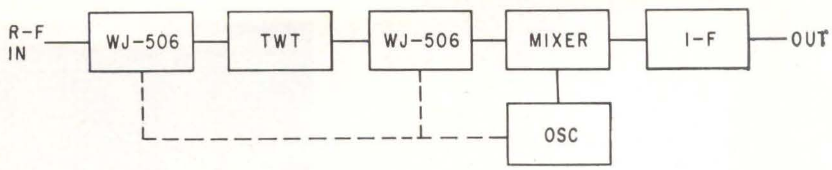
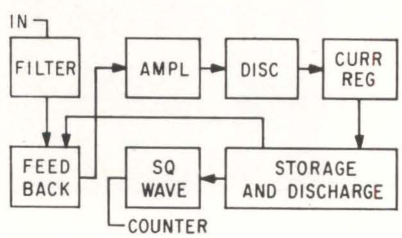


Stanford Industrial Park, Palo Alto, California, the WJ-506 electronically-tuned bandpass filter covers the entire range of WR-90 waveguide. Frequency range is 8.2 to 12.4 Gc, insertion loss at resonance is less than 2 db, 3 db bandwidth is 30 Mc, skirt selectivity is 12 db per octave, and vswr on and off resonance is less than 2. Off-resonance isolation in the band is greater than 50 db, spurious level is −30 db or better, directivity is greater than 25 db and d-c power for ±2 Gc tuning is 3 watts. The device is nonreciprocal and a bandpass transmission characteristic of low-insertion loss is present only in one direction through the filter. Energy traveling in the other direction is greatly attenuated. This allows use of internal resistive terminations which results in matched input and output impedances both on and off resonance without increase in filter insertion loss. Thus the device is equivalent to a bandpass filter with an isolator before it and a second isolator following it. It incorporates a permanent magnet which simultaneously biases two yttrium-iron garnet (YIG) spheres to resonance to obtain a synchronously-tuned bandpass response centered at approximately 10.2 Gc. The filter is tuned by application of current to tuning coils. A second set of tuning coils allows detuning the resonator without changing center frequency. It can be used as a preselector in a microwave receiver to provide selectivity and image rejection. Tracking is simplified by the linear tuning characteristic of the device.

CIRCLE **303** READER SERVICE CARD



Electronic Integrator Operates on Millivolts

MANUFACTURED by Royson Engineering Co., 100 North Penn St., Hatboro, Pennsylvania, the electronic integrator operates directly from millivolt-level signals and has either dry-contact (2 amperes at 115 v) closure output with counting rate of 1,000 counts per minute indicated on front-panel counter or pulse-type output, negative 50-v spikes at 10 μsec duration. The latter model can be provided with output rates of 1,000, 2,400, or 10,-000 counts per minute. Input ranges from 0 to 50 mv at 0 and 50 ma in three steps. As shown in the sketch, difference between input and feedback is impressed on a high-gain, chopper-type amplifier operating into a discriminator and filter. This d-c voltage controls the value of d-c current output of a current regulator operating through the feedback resistor and into a storage capacitor in parallel with a discharge device. On discharge, the pulse operates a second current controller arranged to operate a relay or provide a pulse for high-counting rates. Being a null balance instrument, it has inherent stability. Normal variations in line voltage or room temperature does not cause inaccuracies, zero shift or span change. Error is always less than 1-percent full scale. **(304)**

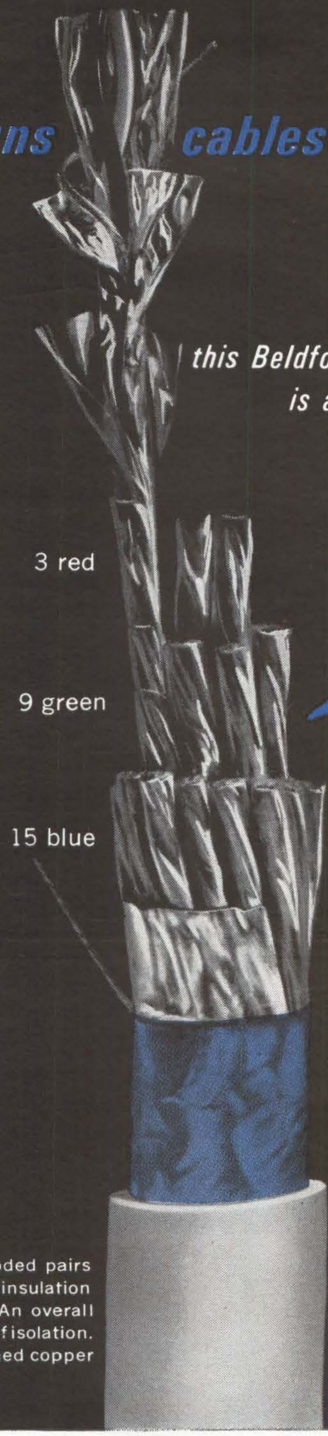
Extending Piezoelectric Gage L-F Response

ON THE MARKET from Endevco Corp., 161 East California Boulevard, Pasadena, California, the model 2614B input amplifier provides an input resistance of 1,000 megohms and gains of 1, 3 or 10 into an output load of 2,500 ohms

Complex? No!

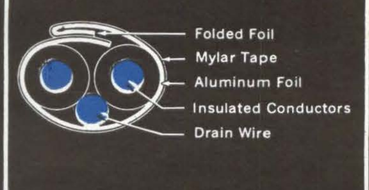
BELDEN designs cables smaller... less complicated

this Beldfoil instrumentation cable is a typical example*



- 27 Insulated, Isolated, Color Coded, and Beldfoil Shielded Pairs
- Drain Wire
- Double Beldfoil Shield Overall
- Polyvinyl-Chloride Jacket

Individually insulated and color coded pairs are protected by a Mylar** tape insulation under a wrapped Beldfoil shield. An overall Mylar tape adds the final measure of isolation. Each pair has its own stranded tinned copper drain wire for shield grounding.



Belden engineers have designed thousands of Beldfoil shielded cables similar to this one..special instrumentation, strain gauge, and control cables. They can and will design a smaller cable to reduce the size of your product..a less complicated cable that will do the same job better..or perhaps a single cable to do the job of two or more different cables. Many well-known manufacturers of specialized electronic products depend on Belden for special cable design. If a smaller, less complicated cable will improve your product..call on Belden.

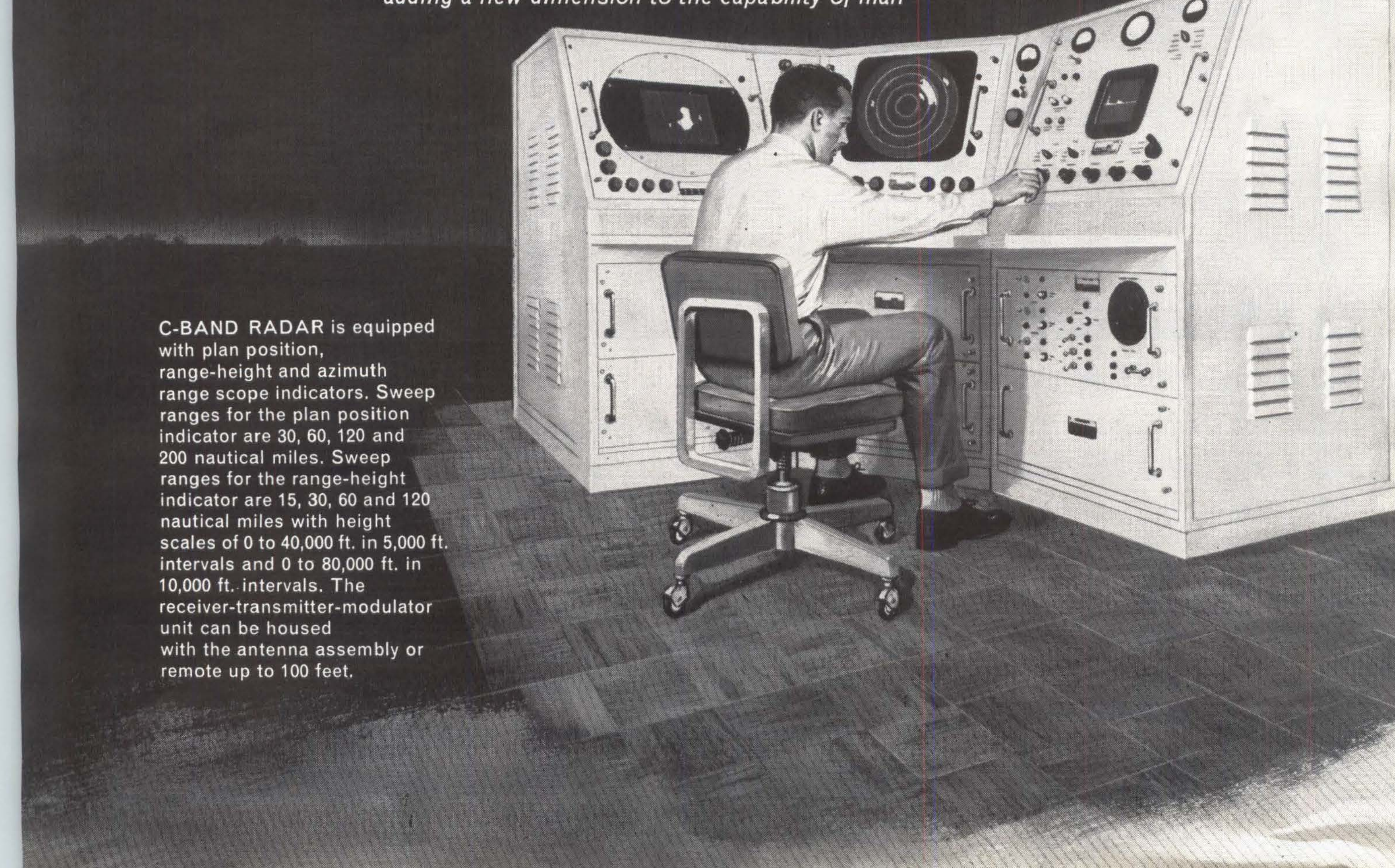
*Belden Trademark Reg. U.S. Pat. Off. **du Pont Trademark

***BELDFOIL** shielding is a lamination of aluminum foil with Mylar which provides a high dielectric strength insulation that is lighter in weight, requires less space, and is usually lower in cost. For multiple-paired cables with each pair separately shielded, the Mylar is applied **outside** with an **inward** folded edge. This gives 100% isolation between shields and adjacent pairs.

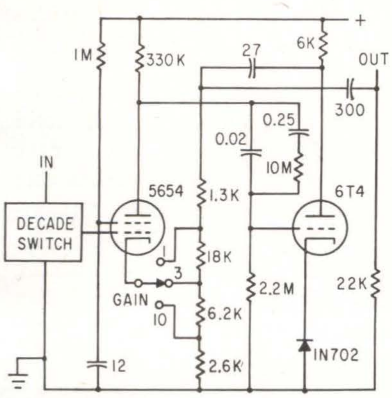
Write Belden Manufacturing Company, 415 South Kilpatrick Avenue, Chicago 80, for data sheet on Beldfoil shielding.

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

8-6-2



or more. This high input resistance, with or without d-c isolation, can extend low-frequency response of piezoelectric gages well below 2 cps. A 3-decade input switch allows selection of shunt capacitance in 10 pf steps from 10 to 9,990 pf to trim sensitivity of piezoelectric gages to a standard value without affecting

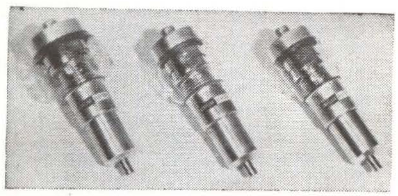


h-f response. Output impedance is 75 ohms resistive in series with 300 μf, output voltage is 5 v rms maximum into 2,500 ohms or 10 v into 25,000 ohms and up. Maximum linear current is 2 ma rms. Frequency response is 2 cps to 20 Kc ± 3 percent and amplitude linearity is ± 1 percent maximum deviation from a straight line between zero and full scale. Total harmonic distortion is 5-percent maximum. The output can drive galvanometers or any load above 2,500 ohms and an external transformer allows for loads as low as 28 ohms. As shown in the sketch, the input couples through a decade capacitance switch to the amplifier. After amplification, the signal is low-frequency compensated and passes to the triode stage. Amount of negative feedback is controlled by the amplifier gain switch.

CIRCLE **305** READER SERVICE CARD

Time Delay Module Uses Semiconductors

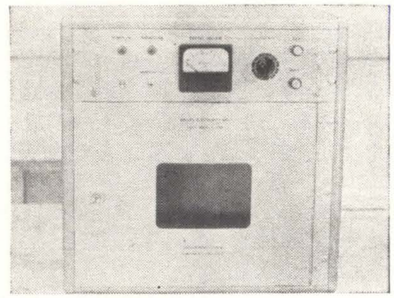
SOLID STATE ELECTRONICS CO., 15321 Rayen St., Sepulveda, Calif. Model 2825-50200 time delay module is of completely solid state design utilizing silicon semiconductors. Unit was designed to overcome many of the inherent deficiencies of mechanical time delay relays. For example, the solid state relay is an inertialess device capable of over one million operations. Actuation time is 1 μsec. Use of silicon semiconductors provides for reliable operation over a wide temperature range of -55 C to $+100$ C. (**306**)



Vacuum Capacitors For H-V R-F Circuits

CALVERT ELECTRONICS INC., 220 E. 23rd St., New York 10, N. Y. Series of compact vacuum variable capacitors have maximum r-f voltages up to 20 Kv and are rated at 40 amp r-f current up to 27 Mc. Range of capacitance available is 5 to 750 pf. These capacitors are suited for use in a wide variety of high voltage r-f circuits in broadcasting, commercial and industrial equipments.

CIRCLE 307, READER SERVICE CARD



High Voltage Tester Offers Portability

AMULEX ELECTRONICS, INC., 467 Connecticut Ave., South Norwalk, Conn., announces model HP-10 portable a-c Hipot tester. Input line is 120 v ± 10 percent, 60 cycles, single phase. Output voltage is 0 to 8 Kv rms, continuously variable. Output current is limited to a nondestructive value of 1 to 2 ma under short circuit conditions. Test chamber is 17 in. wide by 14 in. high by 18 in. deep with "High Voltage Interlocked" door. Overall size is 22 in. high by 21 in. wide by 18 in. deep. **(308)**

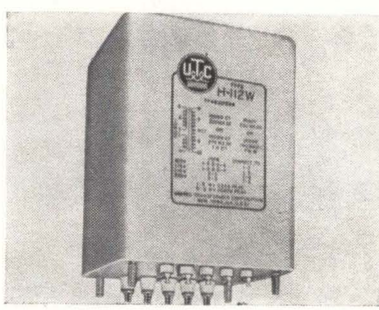
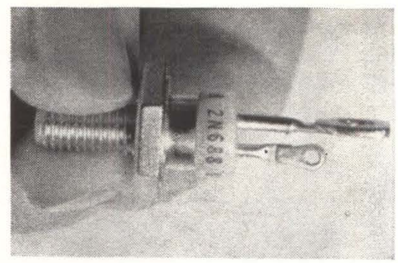


Plate Transformers Sealed in MIL Cases

UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N.Y. Units in the W series of plate transformers are designed to be used for both full wave center tap and full wave bridge rectifier applications. The design incorporates a fully insulated center tap in addition to special insulation throughout the construction. This permits the center tap to be disconnected from ground for full wave bridge application. Units are rated for inductor input filtering. Secondary a-c high voltages range from 1,050 v to 1,900 v center tap. D-C voltages range from 730 v to 1,580 v. Current ranges are from 190 ma to 420 ma. **(309)**

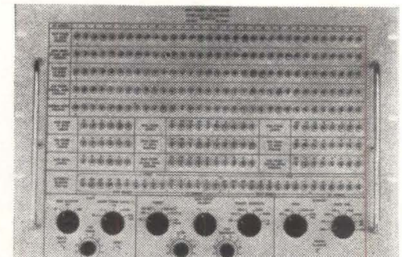
Telemetry Power Supply

SONEX, INC., Tele-datax Division, 20 E. Herman St., Philadelphia 44, Pa. The TEX-3605, an all solid state high environmental power supply developed for aircraft and missile applications where reliability, size and weight are of prime consideration, provides a floating regulated output voltage for use as transducer excitation at loads up to 125 ma. **(310)**



Controlled Rectifiers Come in 18 Types

MALLORY SEMICONDUCTOR CO., Indianapolis 6, Ind., has available 18 types of silicon controlled rectifiers. Featuring blocking voltages to 500 v and current handling capacities up to 25 amperes, the devices are designated by EIA numbers 2N681 through 2N689 (high current) and 2N1842 through 2N1850 (medium current). **(311)**



PCM Signal Simulator Speeds Ground Checkout

CORRELATED DATA SYSTEMS CORP., 1007 Air Way, Glendale, Calif., has

By DICK HAHN
Syracuse, N. Y.
District Office
Non-Linear Systems, Inc.

Solving special temperature measurement problems with a digital voltmeter...

How standard instrumentation and standard methods were utilized by General Electric Company could be of interest to anyone involved in temperature measurement.

THE BASIC PROBLEM

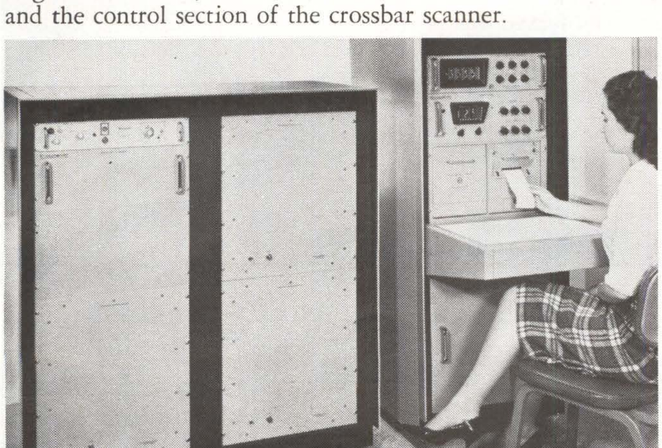
These were the requirements faced by GE and NLS engineers:

- Measure 300 temperatures quickly, approximately 2 seconds per measurement.
- Maintain a resolution of ±10 microvolts, which is ±0.02% of full scale, and an accuracy of ±(0.05% of reading ±10 microvolts) for thermocouple voltage measurement, up to ±55.00 millivolts.
- Provide instantly available data in printed form.
- Measure several voltages as great as 300 volts.
- Provide operating simplicity in instrumentation.
- Separate operator's control portion of the system from the area where measurements are generated.

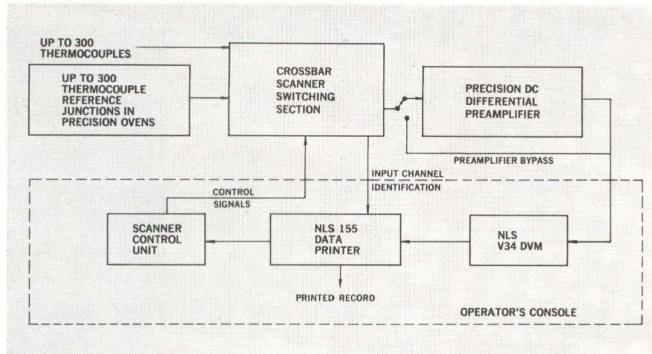
These requirements were met by a remote control data system formed primarily of standard instruments, including an NLS digital voltmeter for voltage measurements and a precision DC preamplifier for millivolt measurement.

FEATURES REMOTE CONTROL

Basically, the system is a two-unit setup connected by a 30-conductor cable 150 feet long. Installed in a cabinet in a hazardous area near the thermocouples are the preamplifier, the switching section of a crossbar scanner, and the temperature-controlled thermocouple reference junctions (±0.1°F). In the operator's console are an NLS V34 Transistorized Digital Voltmeter, an NLS 155 Transistorized Data Printer, and the control section of the crossbar scanner.



This data system, incorporating a digital voltmeter and other standard instruments, measures and records up to 300 widely varying temperatures.



Simplified functional chart of the system.

Without this remote control feature, it would have been necessary to run 600 relatively expensive thermocouple wires 150 feet.

One of the major advantages of the system for this type of application is related to the resolution of the digital voltmeter. Input voltage changes of 0.02% of full scale are instantly recognizable. This means that the numerical display of the DVM will change to a new number for an input voltage change of 10 microvolts. Unlike a strip chart recorder or moving pointer meter, a digital voltmeter eliminates any doubt concerning small input changes. Also, the digital display of a DVM can be read instantly, from close up or 30 feet away.

SYSTEM VERSATILITY

System control is extremely versatile. The input scanner can be set to sample any group of consecutive input channels continuously; stop after one sampling cycle; or sample any single input channel once or continuously upon command. Also, the system can, while monitoring one input channel continuously, record data only when the input voltage changes.

Similar systems are available with a wide variety of options, including more or fewer input channels... strain gage measurements... higher speed voltmeters and recorders... electric typewriters, tape or card punches, magnetic tape recorders... digital clocks for time data... digital comparators for warning or go/no-go tests... AC/DC converters for precise AC measurements... resistance measurements.

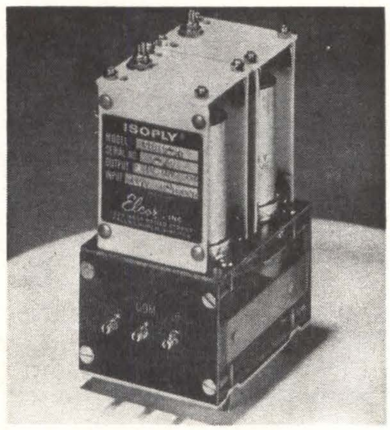
For additional information or competent advice on digital measurements, please circle the reader's service number or contact one of the 19 NLS factory offices located throughout the U.S., or write Non-Linear Systems, Inc., Del Mar, Calif.

non-linear systems, inc.
Originator of the Digital Voltmeter

CIRCLE 105 ON READER SERVICE CARD

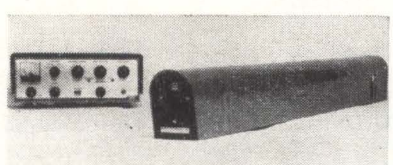
developed model SS-1000 pcm telemetering signal simulator to bring problems of satellite, missile and space vehicle ground check out closer to complete solution. It provides a wide variety of patterns covering bit, word, sub-frame and frame groups as found in contemporary pcm telemetering systems. Approximately 50 p-c cards utilizing all solid state circuitry and fully transistorized modular construction are employed to simulate operating characteristics of satellites using pcm telemetering techniques.

CIRCLE **312** READER SERVICE CARD



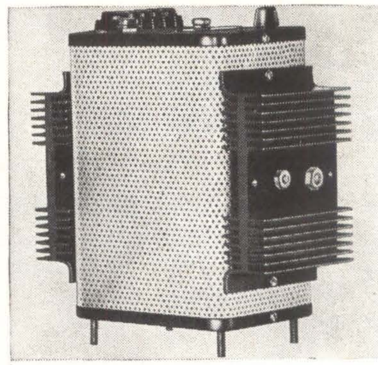
Isolated Power Supply Has Dual Output

ELCOR, INC., 1225 W. Broad St., Falls Church, Va. Suitable for small transistor amplifiers, the A4TD Isoplys offer very low shunt capacitance (25 pf) and a high leakage resistance (in excess of 100,000 megohms) at the output. Ideal for many other applications, they can be used for instance to power an operational amplifier connected for potentiometric (very high input impedance use. **(313)**



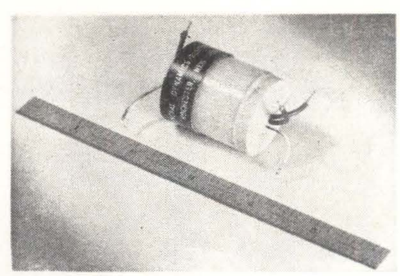
Gas C-W Laser Has Adjustable Mirrors

OPTICS TECHNOLOGY, INC., 248 Harbor Blvd., Belmont, Calif. Model 150 gas c-w laser is a versatile source of continuous coherent light. Standard instrument produces intense beam of visible light at 6328 Angstroms; accessory mirrors available for infrared output at 1.153 microns. The extremely narrow-band output is ideal as a source for modulation, long path interferometer experiments, a variety of demonstrations in classical optics, and various systems applications. The precision mirrors are readily adjustable to produce various optical mode patterns. **(314)**



Power Supplies Fit Small Space

ACOPIAN TECHNICAL CO., 927 Spruce St., Easton, Pa. The JS series transistorized power supplies are narrow enough to be mounted into a 3½ in. rack. Short circuit protection is provided. The series handle current of 1.5 and 2.0 amperes with output voltage ratings ranging from 6 to 25 v. Line regulation is ± 0.5 percent. Load regulation is 0.5 percent. Ripple is 5 mv rms. Internal voltage adjustment of ± 0.5 v is provided. **(315)**

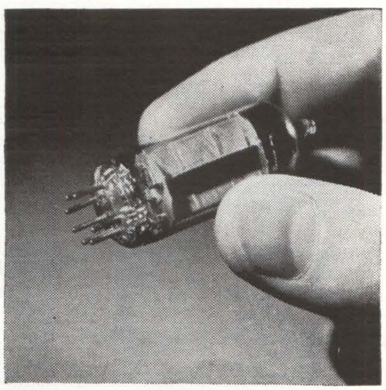


Rugged Preamplifier Provides 20 Db Gain

GENERAL DYNAMICS/ELECTRONICS, 1400 N. Goodman St., Rochester 3, N. Y. Model Q-4 preamplifier, designed for use with deep-submergence hydrophones and high impedance strain gages, is also suitable for many other applications because of its compact size, light weight, and very low noise figure. Providing a 20 db gain, the unit has a response from 5 cps to 100 Kc, with a power requirement of 0.5 ma at 8.4 v. Component derating insures high reliability and long life. Epoxy encapsulation produces a rugged assembly and virtually eliminates microphonic and acoustic coupling. **(316)**

Subcarrier Oscillator

SOLID STATE ELECTRONICS CO., 15321 Rayen St., Sepulveda, Calif. Model V-510 all solid state voltage controlled oscillator, designed for accurate conversion or varying analog d-c voltage to a linearly proportional sine wave frequency, has application within f-m/f-m telemetering systems and as an analog-to-digital converter. **(317)**



Miniature Thyratron Is Zenon-Filled

RAYTHEON CO., 55 Chapel St., Newton 58, Mass., announces a miniature thyratron designed as a pulse modulator or a switching tube in a relay, magnetic clutch, or grid-controlled rectifier. Capable of many thousand cycles of intermittent operation, the CK5727/2D21W is built to withstand the 750-g shock of a $\frac{3}{4}$-millisec impact acceleration test and a 2.5-g vibrational acceleration of a 96-hr fatigue test under 25 to 60 cps. In pulse modulator service, features include a forward peak anode voltage of 500 v, peak cathode current of 10 amp and a peak positive control grid current of 20 ma. **(318)**

Literature of the Week

GYRO COMPONENTS Vernitron Corp., 600 Old Country Road, Garden City, N. Y. Valuable engineering data for gyro systems designers is contained in a brochure giving specifications for 29 gyro components. CIRCLE **319** READER SERVICE CARD

TRIMMER POTENTIOMETERS CTS Corp., Elkhart, Ind. Three single turn subminiature trimmer pots are described in catalog 2500. **(320)**

LINE VOLTAGE REGULATOR Basic Products Corp., Elk Grove Village, Ill., has published a brochure on the theory of design and operation of the Solatron electronic-magnetic type line voltage regulator. **(321)**

FERRITE LIMITERS Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. Technical bulletin covers the WJ-519 low-power ferrite limiters for operation in C band. **(322)**

PRESSURE TRANSDUCER SYSTEMS Consolidated Controls Corp., Bethel, Conn. Bulletin describes pressure transducer systems for monitoring gaseous and liquid media in severe environments. **(322)**

DECODERS & DECIMAL COUNTERS Burroughs Corp., Plainfield, N. J., has available five bulletins describing the new Bipco module decoders and decimal counters. **(324)**

ROTARY SWITCHES Micro Switch, Freeport, Ill. Data sheet 202 describes the IRM series multipole rotary switches with high power handling capacity. **(325)**

TRANSISTOR REGULATOR The Leece-Neville Co., 1374 E. 51st St., Cleveland 3, O. Bulletin TR-5003 describes a new full-semiconductor transistor regulator. **(326)**

PLOTTING BROCHURE California Computer Products, Inc., 305 Muller Ave., Anaheim, Calif., offers a four-page brochure entitled "Digital Plotting with the IBM 1401". **(327)**

ATTENUATION CALIBRATOR Weinschel Engineering, Gaithersburg, Md. Catalog sheet covers model BA-5 attenuation calibrator which can be used to make direct attenuation measurements to 35 db in either the single or dual channel measuring systems. **(328)**

ELECTRICAL CONNECTORS The Deutsch Co., Municipal Airport, Banning, Calif., has prepared a chart containing detailed data on six different lines of cylindrical-miniature, electrical connectors. **(329)**

LINEAR ACCELERATOR High Voltage Engineering Corp., Burlington, Mass. Bulletin describes an 8 Mev microwave linear accelerator for radiation therapy. **(330)**

TERMINAL BOARDS General Electric Co., Schenectady 5, N. Y., offers 16-page bulletin GEA-7317A covering a complete line of sectional and one-piece terminal boards. (331)

BASEBAND REGULATOR ASSEMBLY Lenkurt Electric Co., Inc., 1105 County Road, San Carlos, Calif. Four-page pamphlet describes type 940A1 baseband regulator assembly which is used to improve baseband stability on multi-hop microwave radio systems. (332)

MICROWAVE TEST EQUIPMENT Budd Stanley Co., Inc., 175 Eileen Way, Syosset, L. I., N. Y. Six-page folder illustrates and describes a line of microwave test instruments and components. (333)

SILICON RECTIFIERS Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J. Technical data sheet gives comparative ratings on top hat silicon rectifiers. (334)

RECEIVING TUBES Raytheon Co., 55 Chapel St., Newton 58, Mass. New receiving tubes designed to reduce space requirements and entertainment equipment costs are described in a 19-page loose-leaf folder published for design engineers. (335)

H-F STANDARDS RECEIVER Gertsch Products, Inc., 3211 S. LaCienega Blvd., Los Angeles 16, Calif. Brochure offers information on model RHF-1 all-transistorized high-frequency standards receiver. (336)

THIN LAMINATES The Mica Corp., 4031 Elenda St., Culver City, Calif. A brochure details the Micaply thin glass/epoxy laminates for use in multilayer circuitry. (337)

COIL BOBBINS Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y., has issued the third edition of GRC standard specifications for molded nylon coil bobbins. (338)

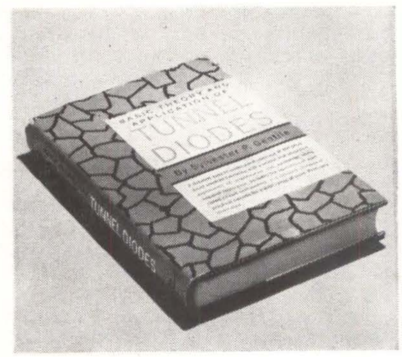
POWER TRANSISTORS AMF Semiconductors, Vandalia, O. Four specification data sheets describe physical and electrical characteristics of *npn* silicon mesa high power transistors. (339)

PRINTED CIRCUITRY Electralab Electronics Corp., P.O. Box 548, Encinitas, Calif. The 14 basic steps in producing circuit boards are pictorially illustrated and explained in a four-page folder. (340)

NEON LAMPS Signalite Inc., Neptune, N. J. Neon glow lamps for use in electronic circuits such as computer and memory circuits are described in technical bulletin 110B. (341)

MICROWAVE COMPONENTS Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J. A 16-page illustrated catalog outlines the significant specifications of the company's complete line of microwave components. (342)

PRINTED CIRCUITS Martin Electronics Mfg. Corp., 3750 E. 10th Court, Hialeah, Fla., has available an illustrated brochure describing its facilities for the manufacture of printed and flush circuits, electronic assemblies, p-c switches and terminal boards. Request on company letterhead.



Basic Theory and Application of Tunnel Diodes

By SYLVESTER P. GENTILE
D. Van Nostrand Company, Inc., Princeton, N. J., 1962, 295 *p*, $9.

ONE of the first books dealing exclusively with tunnel diodes, this text presents their basic principles in a simplified form, without relying on the reader's knowledge of transistor physics.

After covering basic semiconductor theory, energy level considerations, negative resistance and tunneling, the author describes tunnel-diode circuits including series and parallel amplifiers and oscillators, cascading tunnel-diode amplifiers matched to transmission lines, isolators, gyrators, pulse and switching circuits, modulators, detectors, and semiconductor circuits where tunnel diodes are combined with transistors and diodes.

The descriptions use a minimum of mathematics and draw on a large number of practical contemporary tunnel-diode circuits.—G.V.N.

Fundamentals of Electricity and Magnetism

By ARTHUR F. KIP
McGraw-Hill Book Company, Inc., New York, 1962, 395 *p*, $7.95.

A TEXT in classical electric and magnetic theory, this book ranges in subject matter from fundamental electrostatics to electric and magnetic quantum effects. The treatment is on an engineering student level, and presupposes the knowledge of elementary calculus; more advanced mathematical concepts are developed as needed. Some essential concepts of solid-state physics are included, as are some of the phenomena that illustrate the impact of quantum mechanics on classical electricity and magnetism. There are ample problems and examples in each chapter.

Principles of Self-Organization

Editors: HEINZ VON FOERSTER and GEORGE W. ZOPF, Jr., University of Illinois

Pergamon Press, New York, 1962, 560 *p,* $15.

THESE papers, presented at a symposium on self-organizing systems held at the University of Illinois last June, represent five major areas of interest: theoretical and experimental foundations of self-organization; theories of the behavior of complex systems; immunology of self-organizing systems (i.e. how complex systems can be made immune against errors); preorganization in cognitive systems; and componentry. Although only two of the 23 papers deal with specific componentry that will be of importance in the development of highly intelligent, self-organizing machines, electrical engineers should find all these papers fascinating for the light they throw on future computer developments. The recorded discussions by the symposium participants are especially interesting, for they reveal as much as anything the difficulties in breaking into new interdisciplinary ground and in finding a common language in which diverse specialists can talk with one another.—N.L.

Industrial Electronics

By ALLAN LYTEL

McGraw-Hill Book Company, Inc., New York, 1962, 456 *p,* $10.

THIS text covers important industrial applications of electronics not including broadcast or tv equipment. It is intended primarily for use by students at the technical institute level that have had basic electronics, vacuum tubes and other general supporting subjects.

The book is treated with a minimum of mathematics, but does feature some graphs and charts to show interrelationships between variables. Emphasis is given to broad techniques which have wide applicability to a variety of industrial equipment. Particular attention is placed on understanding basic devices and circuits.—B.A.B.

THE INTERNATIONAL SERIES OF MONOGRAPHS ON SEMICONDUCTORS, edited by H. K. Heinisch, University of Reading, published by Pergamon Press, New York, present specialized accounts of various aspects of semi-conductors, written by outstanding authorities. There are five volumes; the fifth, Electroluminescence, by H. K. Heinisch, was reviewed in ELECTRONICS on Sept. 7, 1962. The other four volumes are described below.

Semiconducting III-V Compounds (Volume 1)

By C. HILSUM and R. C. ROSE-INNES

Pergamon Press, 240 *p*, $10.

WITH the fundamental and technical importance of III-V semiconducting materials, physical processes unique to them are discussed concisely yet comprehensively. Band structure, crystal structure, technique of preparation, transport processes, optical, photoelectric and galvanomagnetic properties as well as device applications are presented.

Photo and Thermoelectric Effects in Semiconductors (Volume 2)

By J. TAUC

Pergamon Press, 1962, 248 *p*, $10.

THE physical laws that govern the generation of electromotive forces in semiconductors are given; and a unified treatment of photovoltaic, thermoelectric, photomagnetic and thermomagnetic effects is presented. Special attention is given to the effect of illumination, the presence of temperature gradients or magnetic fields, and variations of impurity content.

Semiconductor Statistics (Volume 3)

By J. BLAKEMORE
Pergamon Press, 1962, 374 *p,* $12.50.

THE SCOPE of this book is confined to the basic properties of semiconductor materials. Part I provides an introduction to the electron theory of solids and then provides a comprehensive discussion of charge carriers for semiconductors in thermal equilibrium (or rather a low-current-density quasi-equilibrium condition). Part II considers non - equilibrium situations, for semiconductors with excess carrier densities. The various recombination mechanisms are considered and steady-state and transient conditions studied.

Thermal Conduction in Semiconductors (Volume 4)

By J. R. DRABBLE and H. J. GOLDSMID
Pergamon Press, 236 *p,* $10.

INCREASING interest in and importance of thermoelectric devices have created a need for fundamental understanding of thermal conditions in solids. Since the book is restricted mainly to thermal conductivity in semiconductors, readers with a practical interest in elemental and compound semiconductors will find particularly useful material. Conduction properties of a large number of semiconductors are analyzed on the basis of theat transport by electrons and by phonons—R. Colman

Lines, Waves and Antennas

By ROBERT G. BROWN, ROBERT A. SHARPE and WILLIAM L. HUGHES
The Ronald Press Company, New York, N. Y., 297 *p,* $10.

AN introductory text on electric energy propagation that presupposes a thorough background in static field theory and circuit analysis. For complete comprehension, the reader should have a basic understanding of differential equations and vector analysis.

Some of the topics covered are transmission line analysis, field equations, radiation of electromagnetic waves, wave-guides and lossless line analysis. An excellent appendix with a well-rounded collection of data closes the book. —B.A.B.

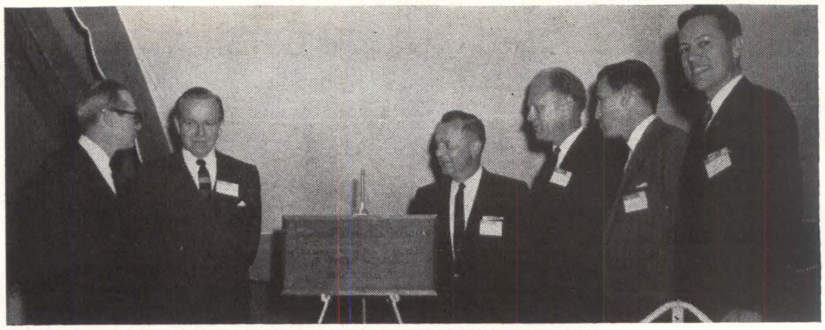
Aspects of the Theory of Artificial Intelligence

(The Proceedings of the First International Symposium on Biosimulation, Locarno, June 29-July 5, 1960)

Edited by C. A. MUSES
Plenum Press, New York, Dec. 1962, 290 *p*, $10.

THE thinking of most of the gentlemen included in this volume—McCulloch, Ashby, von Foerster, MacKay, Pask, Schutzenberger—is by now well-known to readers in this field: it is distinguished by its serious philosophical level, by its articulate imaginativeness and by a speculativeness that is nevertheless grounded in deep scientific knowledge and experience. In the words of Charles Muses, the editor, this "Locarno Conference of 1960 is interesting from the viewpoint of the history of science because it was the first symposium ever held on the general problem of what might be termed 'robotics' or the electromechanical . . . simulation of man by man." This is not a volume for the practical bench engineer; it is for the man who likes to sit by his fireplace late at night meditating on the nature of intelligence and of life with the serious intention of attempting to make working models of it. The volume is far better than most symposium collections.

The odd man in the show might be considered to be K. R. Shoulders, "On Microelectronic Components, Interconnections, and System Fabrication", except for his ambitious program of aiming at fabricating 10^{11} active microelectronic components in a cubic inch, to build the intelligent machines others are dreaming up.—N.L.



FEATURED *in the ceremonies were left to right, Joseph M. Walsh, Instrument division's president; Roswell L. Gilpatric, Deputy Secretary of Defense; John G. Brooks, chairman of the board of Lear Siegler, Inc.; Gerald R. Ford, Jr., U. S. Congressman; Albert G. Handschumacher, president of Lear Siegler, Inc.; and James V. Bitner, Instrument division vice president*

Lear Siegler Dedicates Aerospace Center

LASER BEAM, triggered by Roswell L. Gilpatric, Deputy Secretary of Defense, was recently used to unveil the dedication plaque at the Aerospace Development Center, new 80,000 square foot engineering and research facility of the Instrument division of Lear Siegler, Inc., in Grand Rapids, Mich.

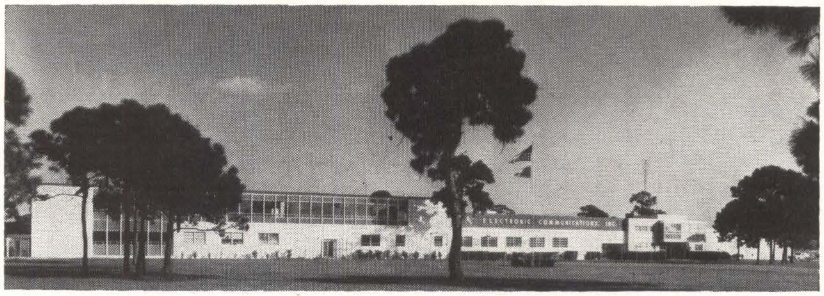
Joseph M. Walsh, Instrument division president, said the new center represents one of the most advanced engineering facilities of its kind in the nation today. "It provides added impetus to our capability to anticipate and fulfill requirements essential to the security and progress of our country," he said.

Designed specifically for aerospace research and engineering, the $1.8 million center houses the latest in precision equipment used in the development of aerospace systems and components. In addition to 8,000 square feet of clean rooms, the building has 12 laboratories. Among these are a solid state laboratory, a systems laboratory, a gyro and platform laboratory, an electronics laboratory, and an environmental laboratory.

The environmental laboratory is one of the best-equipped company-owned testing facilities in the world, according to Lear Siegler officials. One of its features is a space chamber, which simulates the "nothing" conditions and extreme temperatures encountered at orbiting altitudes.

The computer laboratory includes company-owned analog computers, leased digital computers, and additional equipment is on order.

ECI Expands Engineering Facility



AN EXPANDED engineering facility, more than doubling the size of the former building, is to be dedicated on Monday by Electronic Communications, Inc., St. Petersburg, Fla.

Major General Charles H. Terhune, Jr., Commander, Electronic Systems division, Air Force Systems Command, is the principal dedication speaker.

Some 75,000 square feet have been added to the firm's engineering building with the addition of a second floor, a 50-foot extension shown to the left, and a 70-foot extension in the rear. Designed to provide space for an overall expansion of engineering activity, the building in particular incorporates enlarged and improved facilities for the systems management function and for research and development programs.

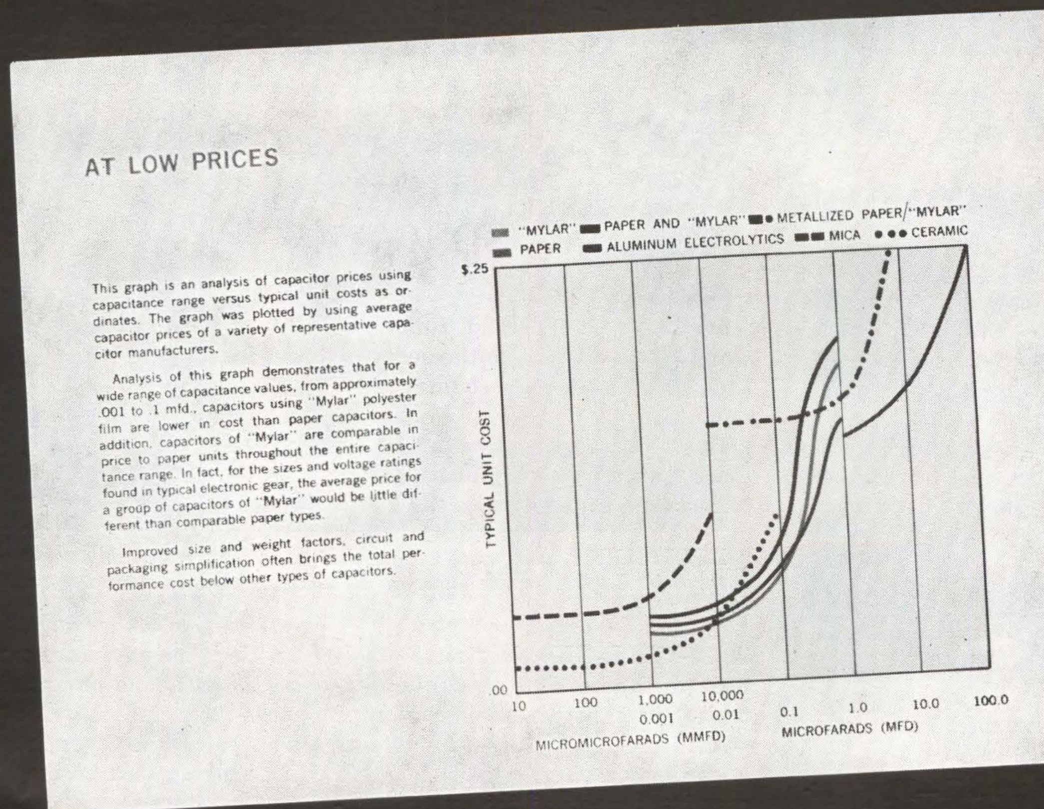
The 125,000-square foot engineering facility combines with a 150,000-square foot manufacturing building to give ECI a 275,000-square foot plant.

With headquarters in St. Petersburg, Electronic Communications, Inc., is prime contractor and systems integrator for the Strategic Air Command's Airborne Command Post and is handling the communication and data link phase of the SAGE Airborne Long Range Input program.

Girdwood Named To New Mallory Post

JAMES GIRDWOOD has joined P. R. Mallory & Co. Inc. as special assistant to the president. Formerly pub-

Capacitors of MYLAR® often cost no more than paper—sometimes cost less



As shown by an analysis of industry prices

A recent industry survey made by Du Pont showed that most design engineers did not consider capacitors of "Mylar"* in the same low price range as paper. Yet a study of manufacturers' average prices, as reported in our capacitor booklet, points out THAT OVER A RANGE OF SIMILAR CAPACITANCES AND RATINGS—UNITS MADE WITH "MYLAR" COMPARE CLOSELY IN PRICE WITH THOSE OF PAPER.

This means, at no greater cost, you get the extra reliability of "Mylar"—superior dielectric strength, moisture resistance, and thermal stability over a wide range of temperatures. And you can design more compact components with the reduced capacitor size permitted by "Mylar".

Write for this industry study and price chart. Evaluate the full advantages and properties of "Mylar" before specifying your choice of capacitors. Du Pont Co., Film Dept., Wilmington 98, Del.

*"Mylar" is Du Pont's registered trademark for its polyester film.

DU PONT
REG. U. S. PAT. OFF.

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

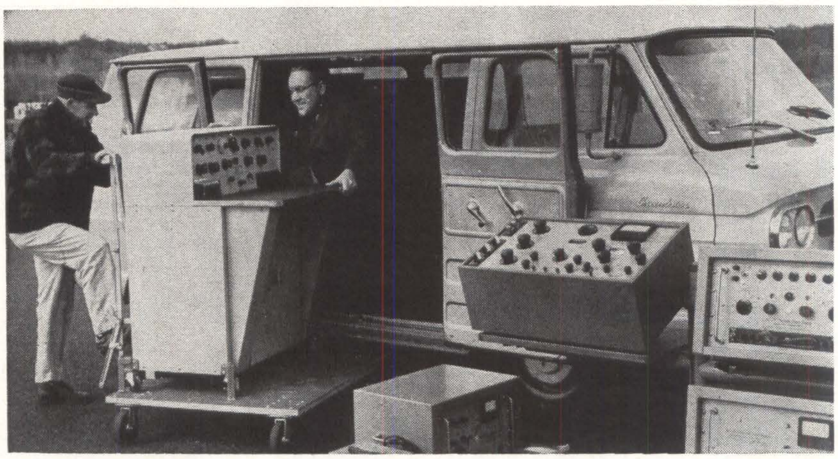
only **DU PONT** makes
MYLAR®
POLYESTER FILM

lisher of ELECTRONICS magazine and, at an earlier date, "Nucleonics", he had been with the McGraw-Hill Publishing Company since 1948.

Girdwood served as a Marine Corps officer. A graduate of the University of Maine, he studied electronics at the Graduate Schools of Engineering of Harvard University and Massachusetts Institute of Technology.

G. Barron Mallory, president of Mallory, said that Girdwood's position includes responsibility for market research, planning and product distribution policies. He will be based at Indianapolis.

Grand Tour for Sales



EQUIPMENT *and panel wagon that are being taken on 20,000 mile trip through Europe to demonstrate RFL equipment in actual operation*

A 27-YEAR-OLD electrical engineer at Radio Frequency Laboratories just began seeing Europe without really trying—or paying.

Anthony Faiola, a bachelor, will spend the rest of this year touring France, Italy, Switzerland, West Germany, Belgium, Holland, Norway, Sweden and the United Kingdom. It will all be part of his job.

Purpose of his travels will be to demonstrate RFL equipment under actual working conditions in European plants, a program that has done much to increase sales of RFL products in the United States in the last few years, according to Edwin S. Seabury, RFL executive vice president.

RFL makes precision calibration standards, power supplies, magnetics equipment and crystal impedance meters. Faiola will have $31,000 worth of these instruments aboard an American panel wagon he will pilot from country to country.

"At the plants we will bring the equipment into the calibration or testing area, or in larger plants into their special demonstration rooms," Seabury said.

"Here the engineers can get their hands on it and our man will work with them and others of the management team to explain cost and time-saving advantages, and how our equipment can speed up the testing of preliminary designs and finished products."

James F. Lavarity, of the U.S. Commerce Dept., calls the RFL program "one which offers great possibilities for American firms manufacturing a variety of goods, electronic or otherwise."

RFL has agreed to furnish the Commerce Dept. with periodic reports of the tour. It said it will also give this information to any American firm requesting it.

Magnavox Building $5-Million Plant

CONSTRUCTION of a $5 million facility in Greeneville, Tenn., for production of color television and black and white instruments plus stereo-tv combinations has been announced by The Magnavox Co.

The new plant will be completely automated and is scheduled for com-

The Best Miniature Soldering Iron In The World . . .

ANTEX-*Precision*
MINIATURE SOLDERING IRON

Low Wattage . . . 110-120 volts . . . no transformer!

Weighs 1 ounce

JUST 6½ INCHES LONG

Model C115

$4.35 EACH in lots of 6 Tips extra

- Life of element and ease of handling are superior to any other miniature iron.
- Sealed element maintains constant temperature around 626°F.
- Ultra-flexible 3-wire cord — grounded — 50 megohms between element and tip protects components and operator.
- Bright "safety" yellow handle stands more than 1000°F . . . stays cool.
- Easy slide-on tips stay hot under production speeds . . . made of tungsten-copper alloy; nickel or iron plated; diameter from 3/64" to 3/16"; spade or chisel ends.

Irons furnished less plugs: heavy duty 2 or 3-pronged plugs available.

M. M. NEWMAN CORPORATION

Dept. 5 — 79 Clifton Avenue, Marblehead, Massachusetts

CIRCLE 206 ON READER SERVICE CARD

I E E E

SPEAK

TO OUTSTANDING ELECTRONICS ENGINEERS, SCIENTISTS, PHYSICISTS

at

I-TRIPLE-E's

International Convention and Exhibition in New York

MARCH 25, 26, 27, 28

The COLISEUM at Columbus Circle & The WALDORF ASTORIA HOTEL

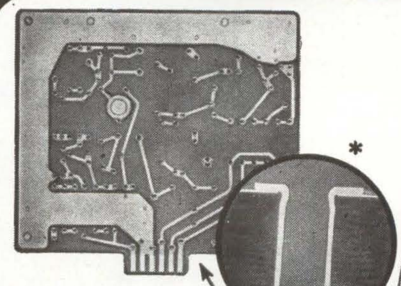
admission: MEMBERS $1.00; NON-MEMBERS $3.00
MINIMUM AGE: 18

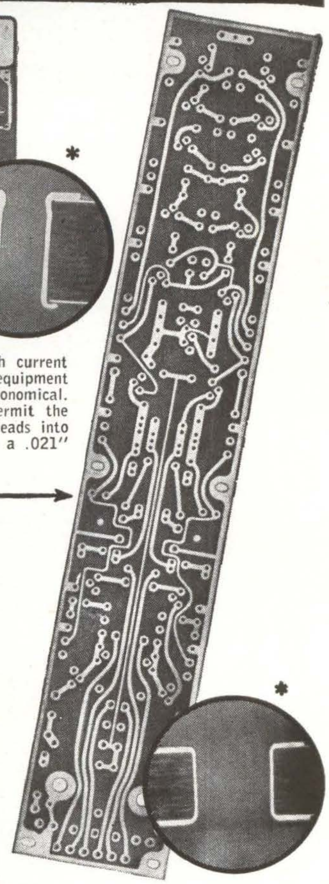
SHOW

(formerly the IRE Show)

Methode *Thru-Connected* Printed Wiring Boards

HIGH { *Reliability!* *Re-usability!*



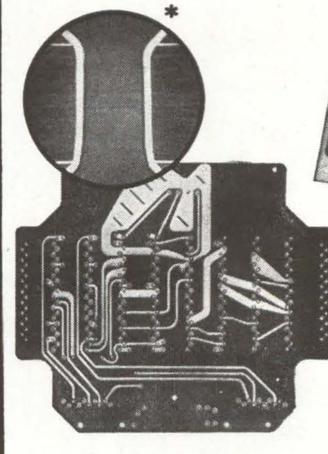


Fused In Place Eyelets

Solder flowed under flanges by high current electrode set dies using latest equipment improvments — fast, flexible, economical. Special Methode techniques now permit the mounting of .016" semi-conductor leads into eyelets which can be supplied with a .021" ± .003" inside diameter.

Plated Thru Holes

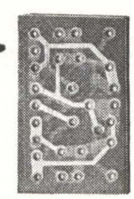
Using copper reduction techniques for sensitizing in conjunction with preclad laminates — compact, reliable, excellent component soldering and high component density.



Funnel Tubelets

Funnel shaped tubelets—permit easy component insertion, repeated removal and re-mounting without damage to board or adhesion — maximum re-usability.

New Three-Dee Sealed Harness



Methode's new fully encapsutated multi-layer circuitry—permits unlimited cross-overs and taps, flexible, conformal, light and tough for interconnecting individual circuit cards or black boxes.

*37 to one micro photographic cross-section view

Use the Best Prefabricated Wiring Technique for Your Requirement . . .

ALL ARE AVAILABLE FROM:

Methode Electronics, Inc.

7447 West Wilson Avenue
Chicago 31, Illinois

pletion in June 1963. Situated on a 90-acre tract of land northeast of the company's present facilities, it will have more than 500,000 square feet of manufacturing area and has been designed to allow for future expansion. The existing tv facility will be placed on a stand-by basis when the new plant becomes operative.

Texas Instruments Appoints Teal

GORDON K. TEAL, assistant vice president—Corporate Research & Engineering at Texas Instruments Incorporated, has been appointed technical director of TI's International division.

Teal is known as the inventor of methods to prepare single crystal semiconductor material for transistors, and as co-inventor of the grown junction transistor. After 22 years on the scientific staff of Bell Telephone Laboratories he joined TI in 1953 to establish the Central Research Laboratories.

In his new assignment, Teal will relocate in Europe with his major objective to create and maximize the flow of technology between TI's international and U. S. operations.

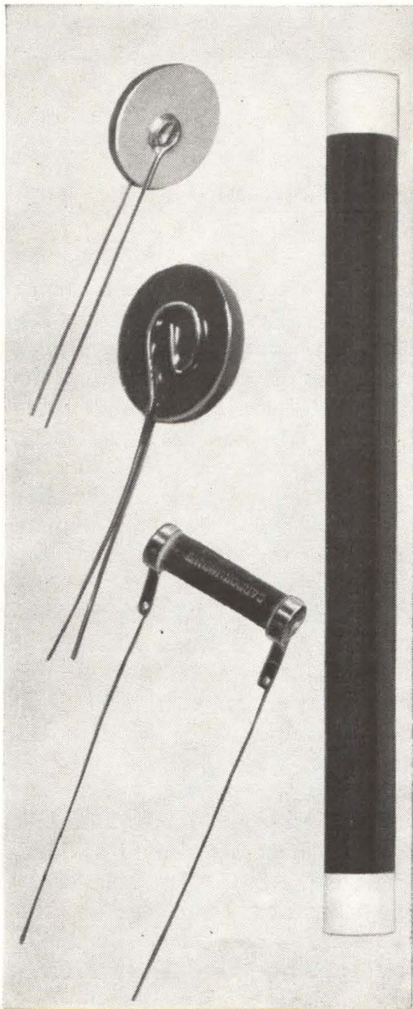
Ishikawa Joins Consultant Group

SAN FRANCISCO, CALIF.—A new engineering link between the U.S.A., Europe and Japan, designed to aid small electronics firms, was recently announced here by Electronic Engineers International.

H. M. Ishikawa, a consulting engineer in Tokyo, has joined EEI and will operate throughout Japan.

EEI is an association of consulting engineers with its colleagues living and working in the U. S.,

ELECTRONIC PRODUCTS NEWS BY CARBORUNDUM



NEWS

New $1½ million electronic facility marks spectacular Carborundum development program

Almost doubling the size of the original plant, a new addition to Carborundum's electronic product manufacturing facilities is now in operation at Niagara Falls.

The new facility provides for greatly increased production of the line of non-metallic resistors, thermistors and varistors. It will also allow for greater diversification resulting from new products developed out of Carborundum's extensive research in solid-state materials, particularly for high temperature applications. Several significant developments in this field are expected to be announced shortly.

Modern manufacturing facilities provide for improved quality control, aimed at precise reproducibility of physical and electrical characteristics of all electronic products. Expanded technical services will be available to assist in the solution of industry problems.

If your product could benefit from application of symmetrical varistors, positive or negative temperature coefficient thermistors, or high temperature ceramic resistors, write for technical data to Dept. ED-12G, Electronics Division, Carborundum Company, P. O. Box 339, Niagara Falls, New York. For evaluation or quotations covering your particular application, please include the necessary particulars.

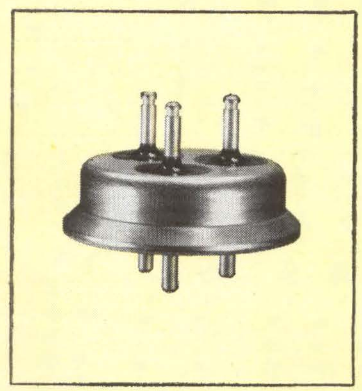
Heavy duty glass-to-metal seals pass stringent tests . . . 2½ million without rejects!

The heavy duty seal illustrated is one of hundreds of types manufactured by Carborundum's Latrobe Plant, for use in electrical and electronic components. This particular example is a refrigerator seal. It must withstand wide swings in temperature and seal against refrigerant leakage.

Quality control checks include cyclic testing for thermal shock resistance from freezing to 500F., resistance to gas leakage at 350 psi and a flash-over test at 2500 volts. Despite these requirements, 2½ million have been supplied to the refrigerator industry without a single reject. Automated production equipment keeps costs of these seals exceptionally low.

Typical of other critical hermetic sealing applications solved with Carborundum's metal-bonded ceramic-to-metal assemblies and metal-bonded ceramics are those involving space capsules and guided missiles, pressure vessels, canned nuclear pumps, thermopile lead-thrus, nuclear reactors, and housings for silicon and germanium rectifiers.

Carborundum's Latrobe plant specializes in all types of glass-to-metal and ceramic-to-metal seals.



For helpful suggestions in solving a variety of difficult sealing problems, contact Dept. ED-12S, Electronics Division, Latrobe Plant, The Carborundum Company, Latrobe, Pennsylvania.

CARBORUNDUM®

England, and Common Market countries. Through an international liaison network they offer services designed to help electronics companies establish themselves in overseas markets.

Ishikawa's work will be to help smaller firms in the U. S. and Japan to exchange knowledge in the fields of electronics and applied physics, and form marketing and manufacturing partnerships.

PEOPLE IN BRIEF

Janis Galejs promoted to a senior scientist at Sylvania's Applied Research Laboratory. **Harvey Riggs,** president of International Electronic Research Corp., elected chairman of the board. **Alvan J. Lynn,** formerly with Daystrom-Transicoil, Inc., appointed senior systems engineer for Kollsman Motor Corp. **Robert P. Scott** advances to coordinator of subsidiary operations at CTS Corp. **Burton Yale** leaves Ramo Wooldridge div. of TRW to join Computer Control Co. as staff engineer. **Paul Kisliuk** moves up to head of the Quantum Electronics dept. at Aerospace Corp. Honeywell Research Center ups **James J. Renier** to asst. director. **David Goldgewert,** ex-PRD Electronics, Inc., now microwave engineer at General Microwave Corp. **Grady B. Hall,** with Lockheed Aircraft since 1950, named director of reliability engineering at Lockheed Propulsion Co. **Paul D. Ross** moves up at GE to g-m of the Specialty Control dept. HRB-Singer, Inc., promotes **Robert Laughlin** to head its new Electro-Optical Laboratory. **Lawrence M. Limbach,** from GD/Astronautics to Ryan Aeronautical Co. as v-p, manufacturing. **Louis J. Metevier, Robert W. Jorgensen,** and **William H. Shaw,** previously division g-m's, elected v-p's for aerospace, commercial products and commercial contracts, respectively, at The Hallicrafters Co. **Robert F. Halligan,** Hallicrafters president, given the additional responsibilities of chief executive officer.

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

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

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ATOMIC PERSONNEL INC. Philadelphia, Penna.	124	1
BELL AEROSYSTEMS CO. Division of Bell Aerospace Corporation A Textron Company, Buffalo 5, N. Y.	93*	2
DAYSTROM INC. Electric Division Poughkeepsie, N. Y.	93*	3
DOUGLAS AIRCRAFT CO. Missiles & Space Systems Division Santa Monica, California	115	4
GENERAL DYNAMICS/ELECTRONICS Rochester 1, N. Y.	124	5
GRUMMAN AIRCRAFT ENGINEERING CORP. Bethpage, L. I., New York	91, 92*	6
JET PROPULSION LABORATORY Pasadena, Calif.	125	7
LOCKHEED MISSILES & SPACE COMPANY Sunnyvale, California	77*	8
ROME AIR MATERIEL AREA (AFLC) Griffiss Air Force Base, Rome, N. Y.	94*	9
SPACE TECHNOLOGY LABORATORIES, INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	13	10
SPERRY MICROWAVE ELECTRONICS CO. Clearwater, Florida Div. of Sperry Rand Corp.	126	11

* These advertisements appeared in the Jan. 18th. issue.

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY ....................ZONE.......STATE.............

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 12563

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

LET'S TALK About the New Field of

AEROSPACE GROUND ELECTRONICS!

The rapidity with which we are reaching further and further into outer space . . . the many new and as yet completely unexplored related technologies . . . are giving birth to a vital new field—Aerospace Ground Electronics.

To be sure, ground support equipment, test equipment design and the like are involved. But the enormity of the tasks which lie ahead require different approaches than before and can only be described in new terms, and by the creation of a new master-field.

General Dynamics/Electronics is very active in Aerospace Ground Electronics and expects to become even more heavily involved. Our preliminary ideas in the field evolve from the disciplines listed below. If you have the required background, we would like to explore the possibilities of AGE with you.

SYSTEMS ENGINEERING

Broad knowledge of Aerospace Ground Electronics design. Will analyze aerospace electronic sub-systems for test requirements and determine test equipment needs. Experience in Air Force Shop or Naval Carrier Installations desirable, with emphasis on equipment layout, intercabling, work flow analysis, operational and calibration procedures.

PROJECT ENGINEERING

Project Engineers to supervise design and integration of test equipments and test stations. Should be familiar with all types of testing equipment and techniques in one or more of the following areas.

- **Flight Control Systems**
- **Radar**
- **HF-UHF Navigation & Communication Equipment**
- **Microwave Equipment**
- **Antenna Systems**
- **Electronic Countermeasures**

DESIGN ENGINEERING

MICROWAVE—Engineers experienced in the design of signal generators and receivers in the following frequency bands: L, S, C, T, Ku, Ka. Should also know techniques for remote control of frequency and signal amplitude.

LOW FREQUENCY—Experience in the design of audio and sweep signal generators and servo systems test equipment. Knowledge of remote control of audio generator frequency and output using digital techniques is desirable, or in cathode ray tube sweep circuits.

HF-UHF—Engineers with experience in the design of HF and UHF signal generators, using both transistorized and vacuum tube circuitry. Knowledge of techniques for digital selection of frequency, such as frequency synthesis, and remote control of signal amplitude required.

CIRCUIT DESIGN

Digital and Pulse engineers with experience in the design of transistorized logic circuits, pulse generators and other digitally controlled circuits such as numerical indicators.

Assignments Immediately Available in:

RELIABILITY SPACE NAVIGATION

ADVANCED DEVELOPMENT & ENGINEERING DESIGN OF DATA & RADIO COMMUNICATIONS

Send us your qualifications now. A discussion can be arranged. Address Mr. R. W. Holmes, Dept. 22.

GENERAL DYNAMICS | ELECTRONICS ROCHESTER

AN EQUAL OPPORTUNITY EMPLOYER

1400 N. Goodman St., Rochester 1, New York

E. E.'s

for FEE-PAID Positions WRITE US FIRST!

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

ATOMIC PERSONNEL, INC.

Suite 1207L, 1518 Walnut St., Phila. 2, Pa.

POSITION VACANT

Test Engineer: Nationally known company in transportation equipment field has opportunity in Research & Development in Chicago area for Test Engr. to immediately assume responsibility for testing program. Require B.S.M.E., B.S.E.E. or M.S.E.E. degree with a minimum of five years' experience in development and application of electronic and electro-mechanical instrumentation. Must have strong backgound in dynamics. Responsibilities include supervising top grade electronic technicians, developing instrumentation, instrumentation techniques and automation experiments. Position vacant due to promotion. Above average benefit program including tuition reimbursement. Please send resume detailing educational background, employment history, and salary requirements. All replies held confidential. P-1387, Electronics, Classified Adv. Div., 645 North Michigan Ave., Chicago 11, Ill.

EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities — executive, management, technical, selling, office, skilled, manual, etc.

Look in the forward section of the magazine for additional Employment Opportunities advertising.

— RATES —

DISPLAYED: The advertising rate is $40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: $2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line. Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. An ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line. BOX NUMBERS count as one line additional in undisplayed ads.

FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons. IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.

PRICES AT A FRACTION OF ORIGINAL COST!

COMMUNICATIONS EQUIP CO.

343 CANAL ST., N. Y. 13, WO 6-4045

CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 950 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR. 584 AUTOTRACK RADARS.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32GCA. AN/APS-10 NAVIG. & WEATHER.
AN/APS-15B PRECISION. AN/APQ-35B PRECISION.
AN/APS-31A SEARCH. DOZENS MORE.
.5-1-2 MEGAWATT HIGH POWER PULSERS.

RADIO RESEARCH INSTRUMENT CO.
550 Fifth Ave., New York Judson 6-4691

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 952 ON READER SERVICE CARD

INDEX TO ADVERTISERS

Audited Paid Circulation

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

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

electronics

Audit Bureau of Circulations | Associated Business Publications

Audited Paid Circulation

JAMES T. HAUPTLI

Advertising Sales Manager

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

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

ADVERTISING REPRESENTATIVES

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

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

CHICAGO (11):
Harvey W. Wernecke, Robert M. Denmead
645 North Michigan Avenue, Mohawk 4-5800 (area code 312)

CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000 (area code 216)

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

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

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

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

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

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

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

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

FRANKFURT/Main:
Matthée Herfurth
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

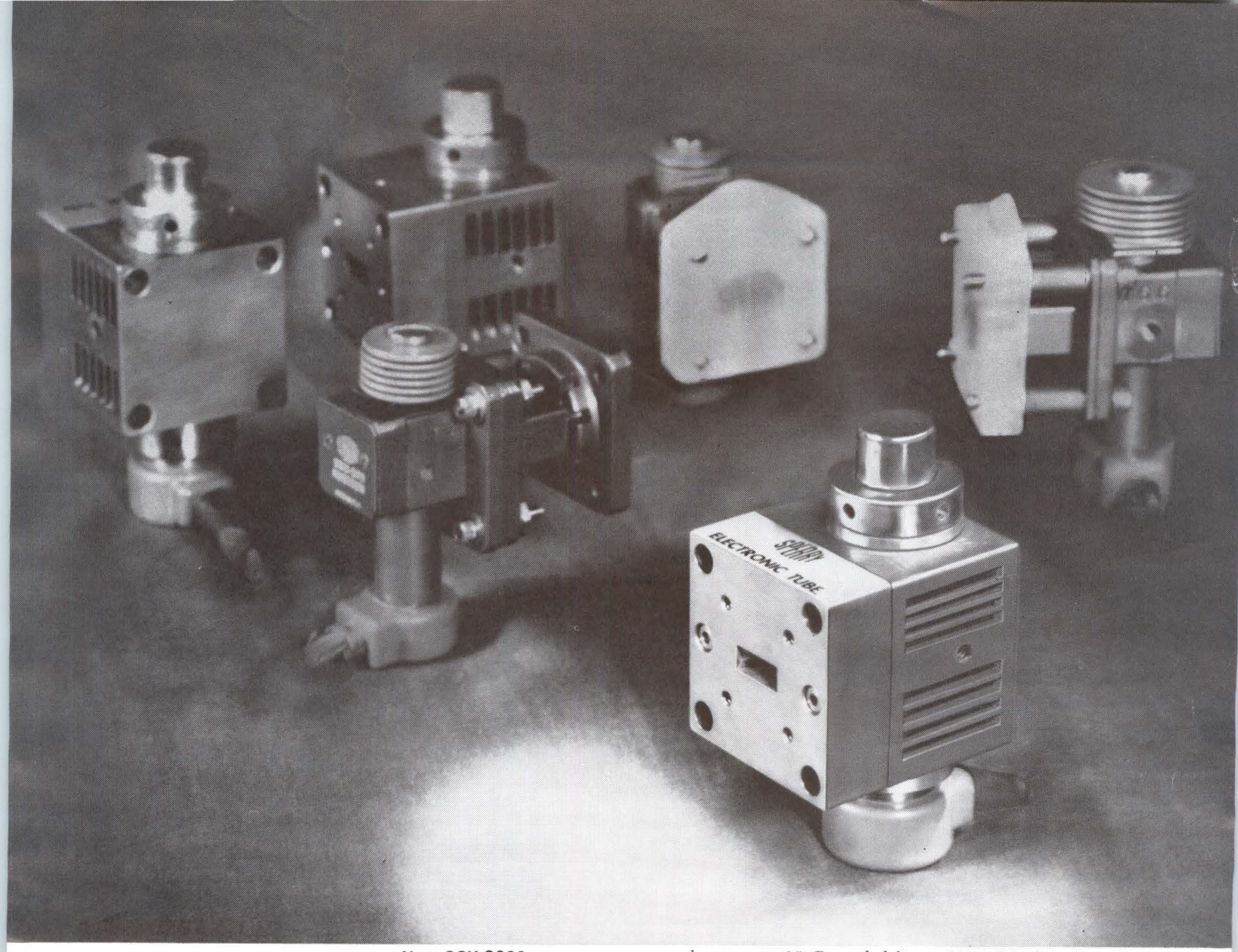
"Headquarters for Business Information"

McGraw-Hill Technical and Business Publications

American Machinist/Metalworking Manufacturing
Aviation Week and Space Technology
Business Week
Chemical Engineering
Chemical Week
Coal Age
Construction Methods and Equipment
Construction Daily
Control Engineering
Electrical Construction and Maintenance
Electrical Merchandising Week
Electrical Newsletter
Electrical West
Electrical Wholesaling
Electrical World
Electronics
Engineering Digest
Engineering and Mining Journal
E & MJ Metal and Mineral Markets
Engineering News-Record
Factory
Fleet Owner
Industrial Distribution
National Petroleum News
Nucleonics
Nucleonics Week
Platt's Oilgram News
Platt's Oilgram Price Service
Power
Product Engineering
Purchasing Week
Science Week
Textile World

Overseas only:
Automobile International (English, Spanish)
Ingenieria Internacional Construccion (Spanish)
International Management (English, Spanish Portuguese editions)
Metalworking Production (Great Britain)

Available by subscription only — to qualified persons actively engaged in the field of the publication. For subscription rates and information describing the editorial coverage of any of the above publications, write to: *Subscription Manager, Circulation Department, McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, N. Y.*



New SOV-2200 pumps paramps and masers at 35 Gc and delivers 500 mW of power. Operation at any frequency from 31 to 40 Gc is possible with this new oscillator family. Although miniaturized these Sperry oscillators have the frequency, high power, and stability of heavyweight tubes.

New miniature, high-power oscillators push range to 40 Gc for paramp pumping

A new family of V band two-cavity klystron oscillators provides high power levels for parametric amplifier and maser pumping, doppler systems, and FM communications systems. These tubes cover the frequencies from 31 to 40 Gc. You now get off-shelf to 60-day delivery of two-cavity oscillators from Sperry Electronic Tube Division at any frequency from 12.5 to 40 Gc.

The unique combination of 500 mW power output at frequencies up to 40 Gc, exceptional AM stability, and small size is found only in Sperry's two-cavity design.

These Sperry miniaturized pump tubes weigh just 12 ounces – yet offer the performance formerly found only in much larger, heavier tubes.

The flat-topped "output power vs. beam voltage" mode shape results in outstanding amplitude stability, since variations in beam voltage and temperature produce only negligible variations in output power.

Sperry's two-cavity oscillators deliver power outputs ranging from .5 to 2 watts. Typical output at U band is 2 watts and at V band, 500 mW.

Use of two-cavity klystrons also permits considerable system simplification, since equipment such as reflector power supply, automatic power leveler, and – in most applications – automatic frequency control can be eliminated.

For applications where outputs up to 300 mW and wide tuning ranges are required, ask about Sperry's tunable, low-voltage reflex klystron pumps.

A free technical booklet describing the entire Sperry line of paramp pump tubes – both two-cavity and reflex – is now available. For your copy, write Sperry, Sec. 182, Gainesville, Florida, or contact Cain & Co., Sperry's national representatives.

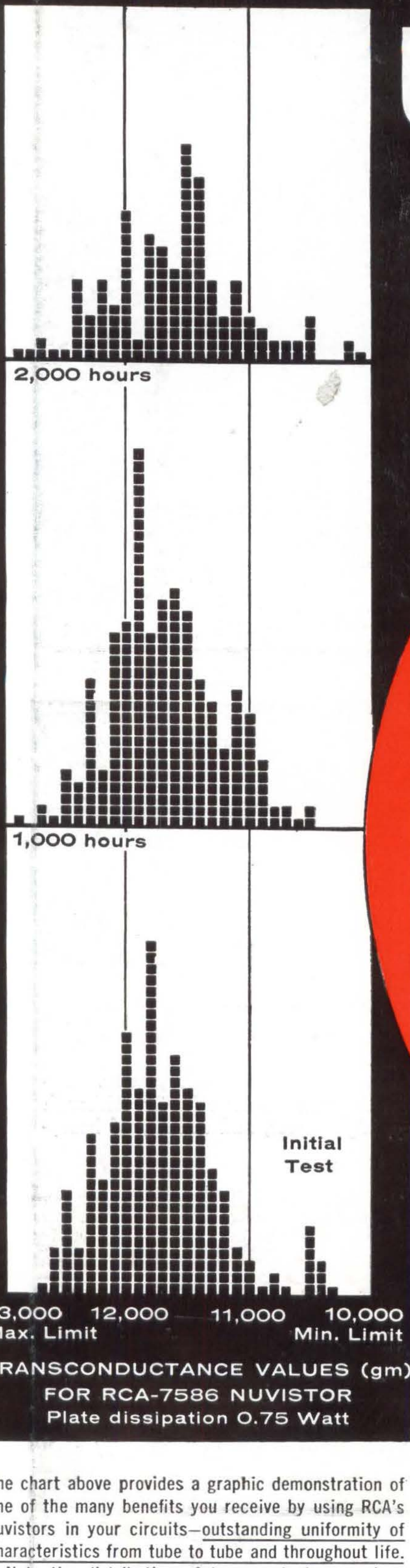
SPERRY | ELECTRONIC TUBE DIVISION

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

CIRCLE 901 ON READER SERVICE CARD

UNIFORMITY...

one more proven benefit of RCA NUVISTORS



TRANSCONDUCTANCE VALUES (gm)
FOR RCA-7586 NUVISTOR
Plate dissipation 0.75 Watt

Each □ represents one tube in randomly-selected sample of 243 tubes.

The chart above provides a graphic demonstration of one of the many benefits you receive by using RCA's nuvistors in your circuits—outstanding uniformity of characteristics from tube to tube and throughout life.

Note the distribution of transconductance values on initial test and the fact that this distribution remains relatively unchanged within the extremely tight limits after 1,000 and 2,000 hours of life tests.

The data compiled in this chart covers a test of 243 randomly-selected RCA-7586 nuvistor triodes. It is typical of the performance you can expect from all nuvistors—as indicated by these transconductance range values of industrial nuvistors:

Nuvistor No.	TRANSCONDUCTANCE RANGE VALUES* (micromhos) Max.	Min.	Plate Volts (dc)	Cathode Resistor (ohms)	Cathode-Bypass Capacitor (microfarads)
RCA-7586	13,000	10,000	75	130	1,000
RCA-7895	10,900	7,900	110	150	1,000
RCA-7587**	12,200	9,000	125	68	1,000
RCA-8056	8,500	6,500	24	100	1,000
RCA-8058	14,800	10,000	110	47	1,000

*with 6.3 volts ac or dc on heater
**tetrode, dc grid #2 volts = 50

Nuvistors offer you the opportunity to design to new concepts of size and dependability. Take advantage of their other benefits—small size and light weight; exceptional reliability; low heater drain; low noise factor; rugged construction; extremely low interelectrode leakage; high sensitivity and stability, and the fact that they are in the class of active electronic circuit components least susceptible to catastrophic failure from nuclear radiation.

For more information on nuvistor call your nearest RCA Field Technical Serviceman or write Commercial Engineering, Section A-19-DE-4, RCA Electron Tube Division, Harrison, N. J.

RCA ELECTRON TUBE DIVISION FIELD OFFICES

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MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois, 527-2900
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