

electronics®

DIODE SPANS 30 MILES

*Infrared beam
carries video, p 38*

SIDEBAND FOR MILITARY

*Latest transceiver
designs, p 29*

CAN RADIO STOP MISSILES?

*Army studies effect
on warheads, p 16*

GAS LASER reads information on magnetic disk, p 48





with these features:

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Constant 50 ohm output impedance!
Rise, decay time less than 1 nsec!

New **hp** 215A Pulse Generator is the ideal instrument for measuring switching, recovery and storage time of diodes, transistors and thin film memory units. The 215A is useful for locating reflection sources in transmission and delay lines, measuring electrical length of cables, determining step response of circuits.

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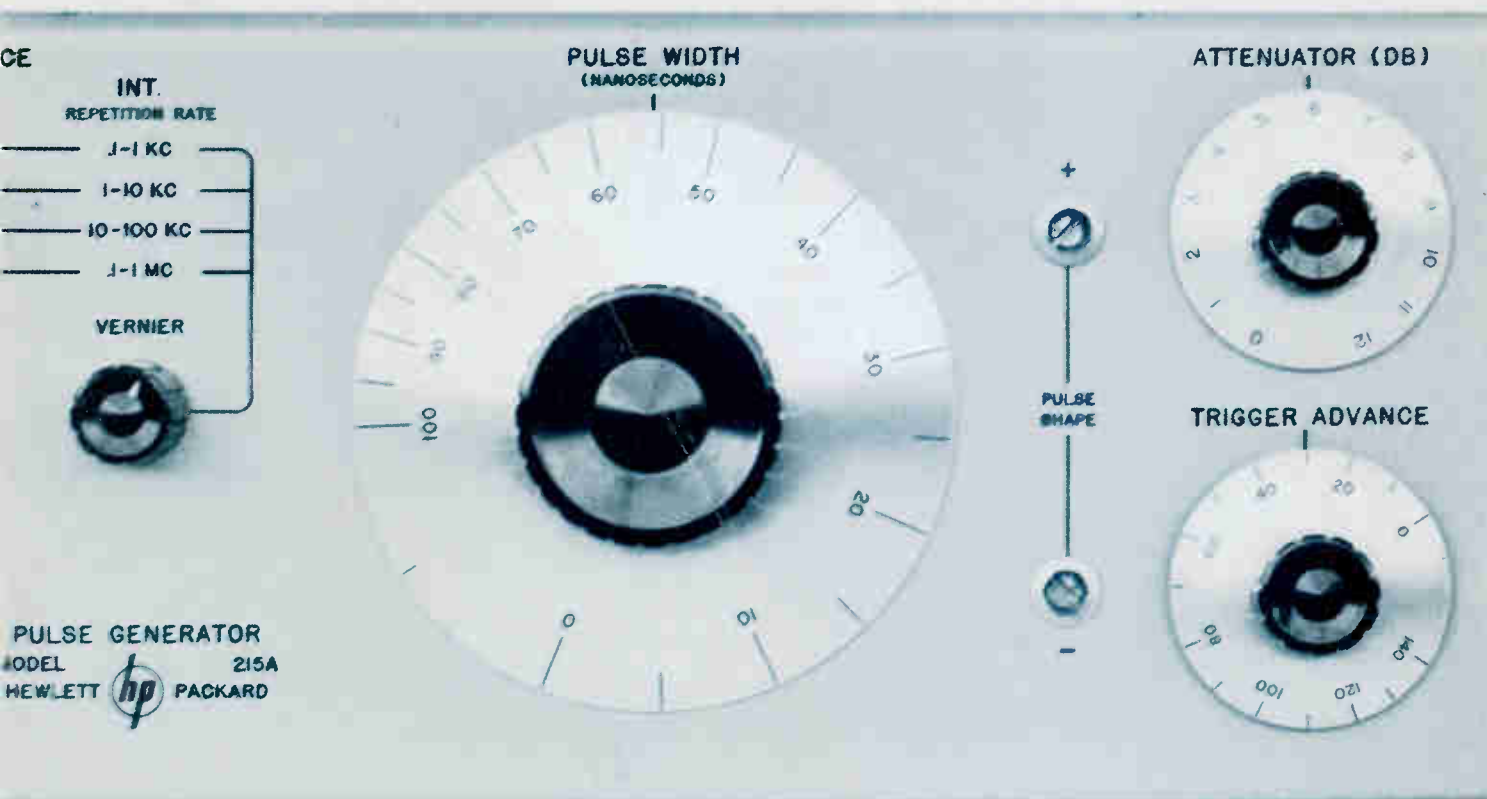
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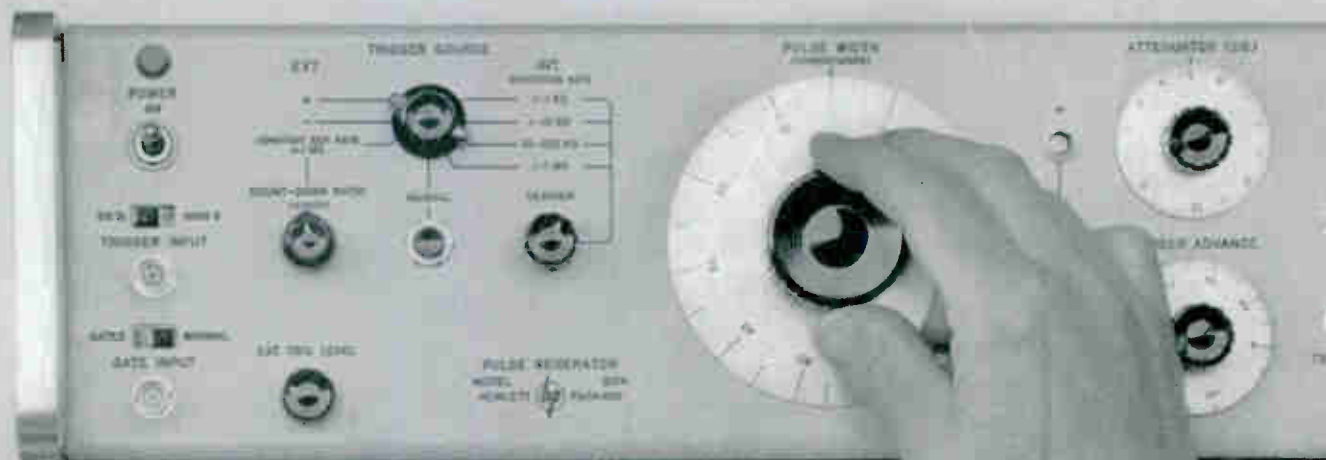


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LASER READS MAGNETIC DISK. Continuous gas laser by IBM scans magnetic disk as Kerr magneto-optical effect from recorded information modulates the reflected beam. At present nonreturn-to-zero information at 500 bits per inch is read back at a 250-Kc rate. *Ability to detect 250,000 bits per square inch seems possible. See p 48*

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By B. A. Briskman 29

TO DETECT 100 FEMTOAMPERES: Use a Tunnel Diode. Low-current instruments are becoming increasingly important in measuring characteristics of improved silicon semiconductors. *This instrument uses the negative-resistance characteristic of the tunnel diode to measure down to 100 femtoamperes (10⁻¹⁵).*
By C. D. Todd, Hughes Aircraft 33

MODULATED INFRARED DIODE Spans 30 Miles. Infrared emission from a gallium-arsenide diode has carried both audio and video signals over a 30-mile path. *Receiver is a 5-ft searchlight with a multiplier phototube at its focus.*
By R. J. Keyes, T. M. Quist, R. H. Rediker, M. J. Hudson, C. R. Grant and J. W. Meyer, Lincoln Lab, MIT 38

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Less Talk, More Discussion

WE HAVE AGAIN returned from an important technical conference where the informal evening discussion sessions attracted capacity audiences. The eagerness with which these sessions are awaited prompts us to ask why such a program must be the exception rather than the rule at electronics engineering meetings.

Much has been said in the past few years about the inadequacy of technical meetings that are devoted solely or primarily to the reading of papers. Complexity of developments reported in most papers is such that the details cannot fully be absorbed when hearing them for the first time—especially by those in the back rows of crowded auditoriums. Without a prior reading and chance for subsequent discussion much of the value of these papers is lost, the audience goes home unhappy and management wonders whether its travel budget is not too high.

Growing awareness of this problem has brought some improvements. We notice, for example, more panel discussions, particularly in areas of high current interest such as millimeter waves and lasers. These seem to be always well attended, proof to us that they fill a need.

Another innovation appeared at a recent technical meeting in New York. Here a 2½-hour session on d-c transmission was devoted entirely to a floor discussion of the formal papers. These papers had been reviewed beforehand by a "General Reporter" who then posed the key discussion questions.

This procedure has been used at European technical meetings, was reported to have won the approval of a majority of the audience for future meetings. We would like to see more of it, particularly in rapidly evolving areas such as lasers and microelectronics where both commercial and technical controversy abounds and interest is high.

Regardless of the mechanism, two things are clear:

- Every attendee should have a chance to read papers beforehand—even if they are only made available the night before in mimeographed form

- An important paper on a complex technical subject cannot then be discussed in three minutes—more discussion time must be made available in some form. And this means speakers should stick around—sometimes we notice they are the first out the door.



TERMINOLOGY. Out of curiosity, we looked through every dictionary in the house for a definition of the prefix femto—used in the word femtoampere headlined on page 33 this week. It isn't in any of the standard dictionaries, but it is a "legal" word. It is the proper prefix for 10^{-16} and much simpler than micronano, millimicromicro or any other combination of better-known prefixes. For the record, after femto comes atto, for 10^{-18} . There is not yet much cause to use atto, but when the day comes atto will avoid such terms as micromicromicro.

Coming In Our April 12 Issue

RABBIT'S FOOT. Naturalists tell us that rabbits have since time immemorial used the earth as a communications channel to warn other rabbits of danger. If an enemy approaches during feeding time, a watchful rabbit will thump on the ground with his hind leg whereupon all the rabbits go down their holes.

Now modern man is catching on to the same transmission scheme (as opposed to the ear-to-the-ground passive listening used by man since primitive times). Next week, K. Ikrath and W. Schneider, of the U.S. Army Electronic R&D Lab, describe their approaches to seismological communications. One of the developments is a transducer that matches signal energy to the earth's impedance.

Other article topics next week include:

- An unusual waveform analyzer
- Multivibrator stabilized by piezoelectric crystals
- Eight ways to get reliability in semiconductor circuits
- Low-noise preamplifier using field-effect transistors
- Solid-state photoflash control
- Graphical design of thin-film resistors.

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For additional information on Sprague Electric Wave Filters, write for Engineering Bulletin 46000 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.



COMMENT

Employment of the Handicapped

Thanks so much for your story on our "Employer of the Year" (p 86, March 8).

Our thanks to you, your New England regional editor, and your *People and Plants* editor, whose efforts may ultimately result in more jobs in the electronics industry for handicapped men and women.

PATRICIA FENTON

The President's Committee on Employment of the Handicapped
Washington, D.C.

Postal-Card Compliment

A card I *do* send is better than the letter I don't get around to. I wanted to compliment you on some nontechnical aspects of the magazine.

The summaries (abstracts) of articles, both in text and table of contents, are a good feature. Like also your use of "ordinary" type as headlines, etc. — very attractive (looks much better than one would expect!).

Also liked Jan. 25 cover—color is used artistically. Appreciate your international authorship—and errors seem to be decreasing.

NICHOLAS BODLEY

Castleton, New York

Bombers and Radar

The editorial in the Jan. 11 issue, *We Need Bombers Too* (p 3), comments unfavorably on the statements of Mr. Harold Brown, Director of Defense Research and Engineering, regarding radar and mach-3 planes.

My personal experience with a number of systems involving military radar units supports Mr. Brown's comments. Problems of maintainability, reliability, and operational capability are inherent in most of the designs. The majority of radar equipment presently supplied is inferior in reliability and mean-time-to-failure of other equally complex electronics equipment such as computers and communications equipment.

The statement that as a result of Mr. Brown's attitude, "state-of-the-art progress grinds to a halt" is, I believe, in error. The proper rebuttal to Mr. Brown's remarks will be in the form of an all-solid-state radar meeting the mach-3 and higher requirements, with maintainability and reliability numbers comparable to those of other electronic devices of like complexity.

Let us consider comments such as these as a challenge to the industry and the engineering profession, rather than an edict to stop progress.

One last comment: none of the 3,200 V-2 rockets fired at England had an atomic warhead, and I doubt if England could have survived a bombardment of even one percent of that total if today's warheads had been used.

R. W. TACKETT

Wayne, Michigan

We, too, feel that the proper reaction to the pessimism of Dr. Brown (PhD in nuclear physics, not electronics) in regard to radar for a mach-3 plane, should be a desire to prove he is wrong.

The fact that V-2 rockets fired at England did not carry atomic warheads, was precisely the point we were trying to make. They carried conventional warheads, and therefore caused little damage. For this reason we find Defense Secretary McNamara's suggestion that ICBMs might carry conventional warheads all the more surprising.

Snap-Off Diodes

Referring to my article, *Improving Pulse Rise Time With Snap-Off Diodes* (p 68, Feb. 15):

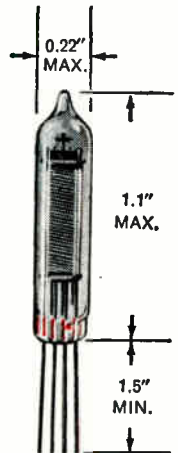
The caption for Fig. 5 should read: "Switching circuit signal waveforms obtained by the use of strobing pulses from one (A), two (B) and three (C) charge-storage diodes are shown at 0.2 nsec per division."

On p 69, column 4, 4th line from bottom, Fig. 4 should read as Fig. 5.

K. C. HU

David Sarnoff Research Center
Radio Corporation of America
Princeton, New Jersey

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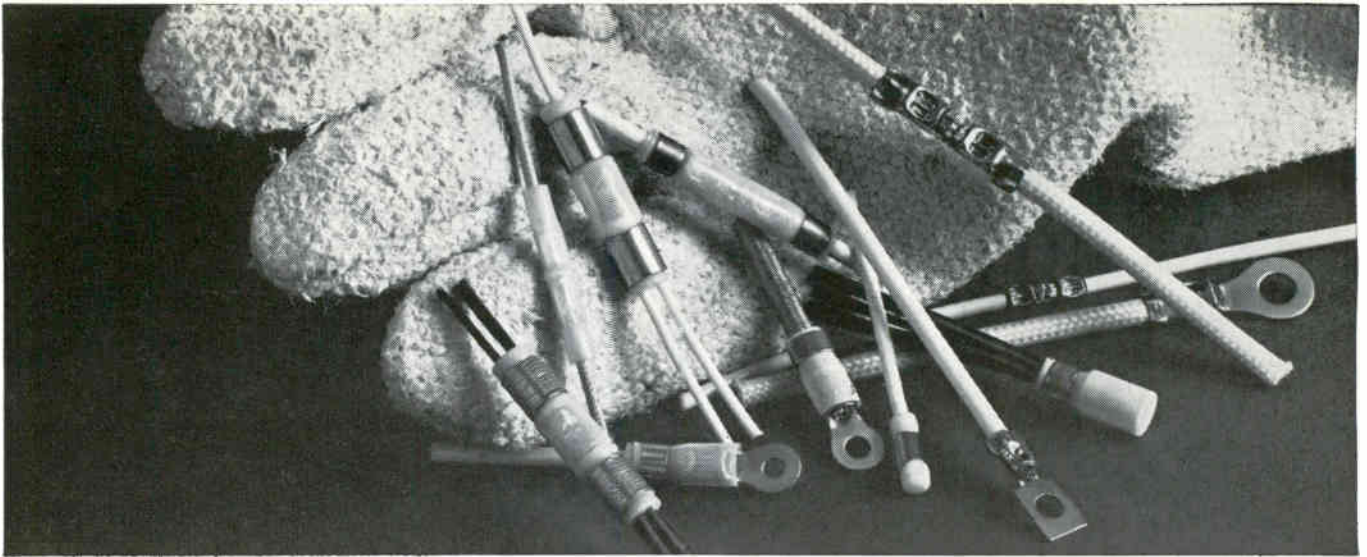
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Grid Supply Voltage	
—for max. light output	0 volt
—at zero light output	-3 volts
Anode Current	
—for max. light output	585 μ A
—at zero light output	5 μ A max.

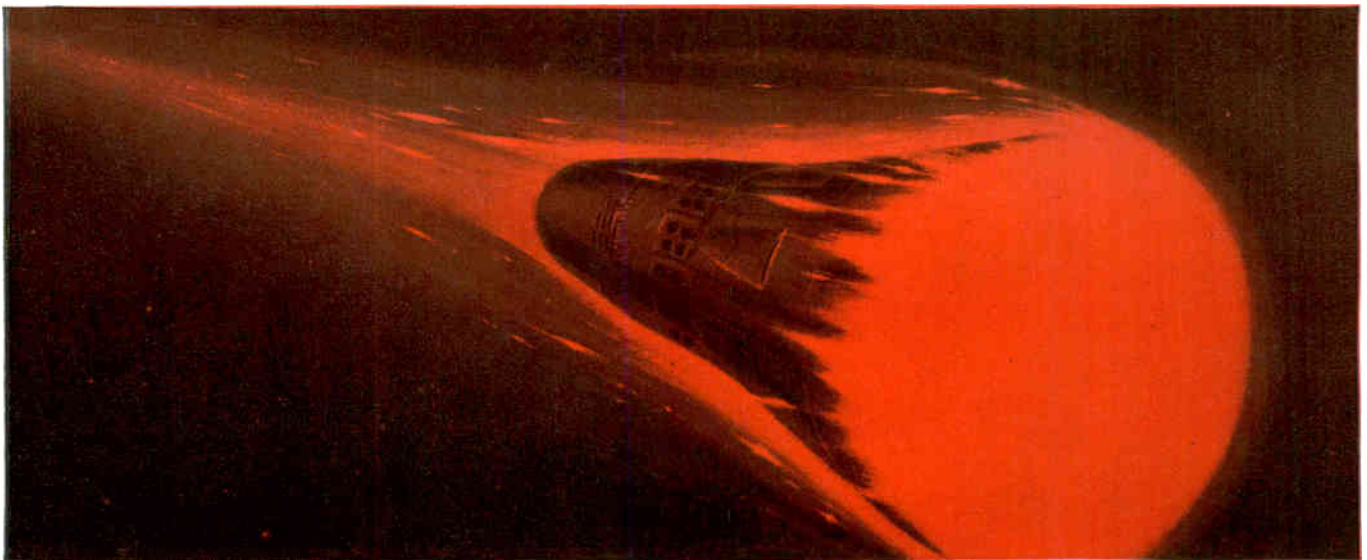
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Fifth Layer May Limit Anti-ICBM Radar

PREVIOUSLY UNKNOWN ionospheric layer may exist 330 miles above the earth, restricting the useful power of missile-detecting radars, says Richard C. Beitz of Cornell Aeronautical Laboratory.

Beitz in an IEEE paper, said that during investigation of the ionosphere with the CAL 48-Mw, 2,850-Mc, pulse radar, distinct returns were received from this layer. Odds are 400 to 1 against the returns being random noise, he said. The layer would be the fifth in the ionosphere, above the F-layers.

Beitz pointed out that anti-missile radar noise limits are set by energy backscatter from the target region. If a missile, particularly a small missile, flew in and around this new layer, backscatter could conceal it. Increasing radar power would not improve detection, just as more powerful auto headlights do not give better vision in fog.

Beitz said the layer is apparently a cloud of electrons about 10 miles thick with other dimensions unknown. How many clouds there are, their exact composition and orbit paths are not known.

In recent months, the Alouette sounding satellite has indicated that something does exist around this altitude but nothing could be seen with conventional radars. Beitz said these lack sufficient transmitter power and the computer integration systems CAL employed to detect the clouds. There is no evidence that the clouds are the result of high-altitude nuclear shots.

Bill Would Protect Employee-Inventors

BILL HAS BEEN introduced in the House of Representatives by Rep. George E. Brown Jr. that would outlaw agreements giving employers the patent rights to their employees' inventions when such agreements are a condition of employment.

Sponsor is the Council of Engineers and Scientists Organizations—West, which says it represents over 20,000 engineers and scientists primarily employed in the California aerospace industry. The Council said: rights of employee-inventors were ignored in hearings just completed in the Senate on government ownership of patents (p 12, March 29, and p 12, March 15).

Ionospheric Sounder May Detect Nuclear Debris

SAN FRANCISCO — Granger Associates has just completed operational tests of ionospheric sounding equipment to determine its utility in improving efficiency and reliability of h-f communications.

Tests were conducted with the AF along a 2,000-mile transmission path from Elmendorf Field, Alaska, to McClellan Field, Calif. The system gives a crt display of distortion and time delay of transmitted pulses. Pulses at up to 120 different frequencies between 4 and 32 Mc are transmitted. Granger says the tests furnished operators with data on the highest and lowest usable frequencies, as well as multi-path distortion at all times.

The equipment is being suggested in some circles as an effective means of detecting nuclear

Adaptive Trainer



TRACKING SIMULATOR that adapts to the efficiency level of the trainee uses an analog computer with servo feedbacks to measure and control six flight characteristics. Servos feed error signals back into the computer to cope with trainee's changing proficiency. Otis Elevator says training time is cut 250 percent.

debris in the ionosphere, since high altitude particles caused by nuclear blasts might distort or delay transmitted impulses. Granger, however, would not comment on this.

100-mw Gas Laser Output At 6,328 A Is Reported

GAS LASER that produces more than 100 mw of c-w power at 6,328 A and a method for mechanically tuning gas lasers have been developed by Spectra-Physics scientists.

Attendance Down at IEEE Show

ATTENDANCE at last week's IEEE Show dropped to 70,432 from last year's IRE Show total of 73,400, the IEEE said.

Donald G. Fink, IEEE general manager, replied, "Your guess is as good as mine," when asked for a reason for the decline. He guessed that tighter government restrictions on expense-account spending—by Internal Revenue Service and DOD—were partly responsible.

"But it's silly to get in a numbers race," he said. "The main thing is the convention doing the job it's intended to do?" Judging by the comments of many exhibitors, who praised the quality of attendance, "this is the most effective convention we've had yet," Fink said.

The 100-mw laser, constructed by Earl Bell, is four times more powerful than any gas laser previously reported, Spectra-Physics said. It is 3 meters long and 15 mm in diameter. An internal confocal mirror resonator is used. Firm says it may eventually give several watts.

Arnold Bloom reports suppressing the dominance of the 6,328-A transition in a gas laser over other population inversions between 3s₂ and 2p levels by incorporating a fused quartz prism into the laser resonator cavity. Visible lines were observed at 6,403, 6,293 and 6,118 Å. The latter is the shortest wavelength gas laser transition to date, it was reported. The various laser outputs were made visible by mechanical adjustment of a mirror.

Spectrum Display Spots Tv, F-M Troubles

CHICAGO — Spectrum display for spotting spurious radiations and other troubles was described by Granville Klink of WTOP, Washington, D. C., Monday at opening session of Broadcast Engineering Conference here. Monitor displays f-m and vhf-tv spectrum in segments—from 50 Kc to 2 Mc—on a 5-inch screen calibrated horizontally in frequency deviation and vertically in db.

In another paper, Robert Morris of ABC said that government radio reference signals permit low-cost broadcast of split screen or montage pictures from several widespread sources without pulling or flipovers. Canal Zone 18 Kc vlf-station NBA has sufficient power for remote point synchronization over most of the country, he said.

ABC experimental setup, operating in the nanosecond range, calibrates the NBA signal against the locally available sync signal, figures out the difference, and corrects to the standard set up by the mixing point.

NAB Challenges FCC On Loud Commercials

NAB OBJECTED last week to the FCC's probe into overly loud radio and tv commercials (p 18, Jan. 18).

It said loudness is apparently a "subjective and psychological" phenomena which lies outside FCC jurisdiction. However, commercials are sometimes louder than the adjoining program material, NAB said. Producers of commercials, it explained, often strive for a "brilliant" sound.

Wireless Transmission Of Power Improved

WIRELESS TRANSMISSION of power (p 7, July 6, 1962) has been increased to 70 percent efficiency, said Profs. R. H. George and E. M. Sabbagh, of Purdue University at the IEEE Convention.

They said they transmit power in a sharp beam of microwaves and convert it into d-c at the receiver. Special semiconductor diodes, they believe, will achieve efficiencies over 90 percent and increased power. They have produced up to 40 w with their present model.

Refractometer to Give Microwave Index

BEDFORD, MASS.—Light, inexpensive refractometer to be flown on conventional weather balloons is under development at AF Cambridge Research Labs to provide continuous profile of microwave index of refraction for radar tracking of missiles and rockets during launch. Instrument will consist of dual microwave cavity, one end open to the air and the other sealed but connected to exposed cavity. Proposed 5-inch model will operate at about 1 Gc.

British Setting Up Exhibit in Red China

HONGKONG—British sources here say that negotiations are now going on for a British exhibition of scientific instruments and associated equipment in Peking at the end of this year. It will be the first of four trade fairs to be held in Communist China by British manufacturers. The fairs follow a request by the Chinese Communist government trade organization to the Sino-British Trade Council.

In Brief . . .

MOSCOW SAYS the Soviet Mars probe, launched last November, is expected to "rendezvous" with the planet June 19. Vehicle will have traveled 500 million kilometers by then.

JAPAN PLACED restrictions on production of two-transistor radios April 1.

R&D CONTRACT for gas discharge ion rocket space propulsion system was awarded Electro-Optical Systems, Inc. by NASA.

PURCHASE of Auto Data, Inc. was announced by Houston Instrument.

HONG KONG'S trade in electronic instruments last year hit \$25.5 million (in U.S. dollars).

AMERICAN engineering schools can use three times as many graduate fellowships as are now available, according to Engineers Joint Council survey.

TELSTAR II, now scheduled for launch early in May, will be put into an elliptical orbit of 500 to 6,000 miles to help protect it from radiation (p 30, Jan. 11).

HIGH-PRICED microwave tubes would be leased, instead of sold, to the government under a plan proposed by Warnecke.

NASA GAVE Lear Siegler three contracts totaling \$6,577,000 for electronic systems at Marshall Space Flight Center.

ARMED FORCES DAY military-amateur radio communications program will be held May 18.

DIXSON PRODUCTS and General Meters, Inc. will merge.

FAA ORDERED 8 more bright-display systems from Raytheon for \$3.4 million. This makes 68 it has bought from Raytheon at a total cost of \$18.5 million.

LIBRARY OF CONGRESS has opened a referral center for science and technology.



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SOLID TANTALUM CAPACITORS
Meet Minuteman Goal April, 1962**



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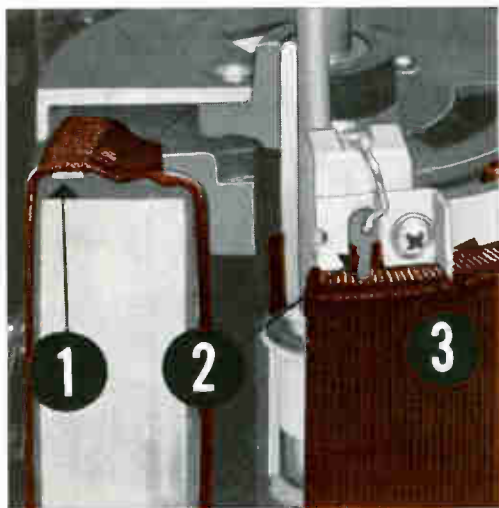
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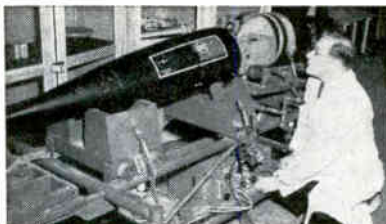
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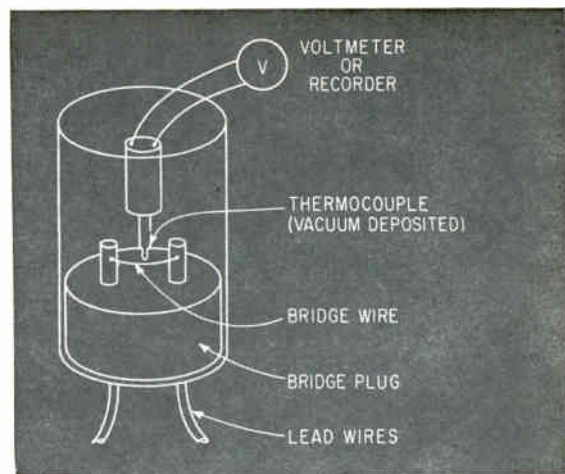
INDUSTRIAL DIVISION

CIRCLE 15 ON READER SERVICE CARD



LITTLE JOHN missile warhead being prepared for r-f test by A. Grinock, unit chief, Technical Services Lab

SIGNAL CORPS BC-339-N transmitter, shown here under adjustment, is one of two that cover short-wave range of hazards facility



R-F HAZARDS SENSORS are a and a crystal video detector, right, caps, used in missiles both to

Army Protects Missiles

Develops new techniques to keep warheads safe near strong transmitters

By **GEORGE V. NOVOTNY**
Associate Editor

DOVER, N.J. — AA2XV are the call letters assigned by FCC two weeks ago to a unique radio station authorized to operate on all frequencies from 100 Kc to 10 Gc.

Its task is to protect our missiles and ordnance items from being blown up accidentally by a burst of radiated r-f from a radar, communication, or command transmitter that has just the right frequency and field strength to actuate the warhead squibs.

Station AA2XV is part of a new installation being raised by Army's

Munitions Command at Picatinny Arsenal, to study the effects of radiated r-f on nuclear and conventional warheads, projectiles and other electrically triggered ordnance items.

The facility will base a continuing program to test all ordnance items as developed for susceptibility to r-f heating. Testing has started on warheads to develop standards for r-f environment tolerances at weapon sites.

Picatinny is also developing protective filters to keep harmful r-f radiation out of explosive squibs in ordnance items, and studying skin shielding techniques. Other protective measures may include coded actuating devices not susceptible to ordinary r-f.

SIX TRANSMITTERS—The wide frequency range will be covered by

six separate transmitters, with radiated power capability of 250 to 500 watts c-w and pulses over 1 Kw in the 350 Mc to 10 Gc range, and over 1 Kw in the lower ranges; there will be provisions for frequency sweep, modulation, and for vertical, horizontal or circular polarization. Field strengths at the site will range up to 100 volts/meter for the far-field tests.

POWER SENSORS — Warhead tests are conducted on specimens wired with sensitive ambient-temperature-compensated vacuum-deposited thermocouples, installed within 0.003 in. of the squib bridge wires.

Developed by the Naval Weapons Lab in Dahlgren, Va., these sensors can detect power levels of 200 microwatts in the bridge wires, without disturbing in any way the r-f integrity of the missile. Other r-f sensing devices are small crystal video detectors, which are more sensitive but have to be wired into the missile circuit.

Army spokesmen said Picatinny will conduct further development of more sensitive sensing devices, and testing techniques such as the use of modulated r-f to eliminate effects of noise and temperature variations.

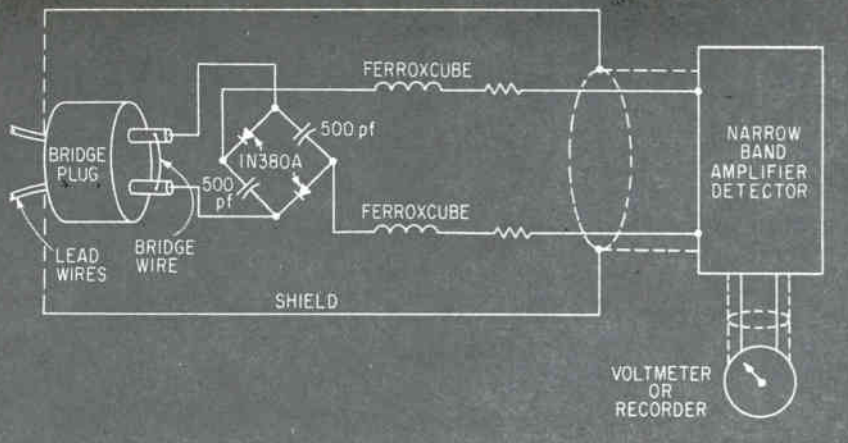
TEST FACILITIES—When completed, the Army facility will have a large r-f anechoic chamber where smaller items can be tested without outside radiation. For low

RADIATION AS A WEAPON?

Can r-f radiation be used to down enemy missiles, either as an offensive weapon or as a protective shield surrounding a large area?

Army won't say, and Picatinny is not working on this aspect of the problem for the time being. It appears that a lot of power is required for such action—too much, with available power sources, for mobile r-f antimissile projector units. An r-f shield protecting a country would be a mammoth project using the power of many Niagaras, and probably could not guarantee any results.

But all this may change as we learn more about what happens when r-f gets inside a missile, and as smaller and more powerful energy sources are developed



thermocouple detector, inserted in a squib but not touching bridge wire, left, connected in parallel with bridge wire. Squibs are d-c current-operated explosive detonate charges and as relays to operate switches

Against Stray R-F

r-f frequencies, a cage is being developed in which low-frequency radiations will be simulated by generating alternate electric and magnetic fields perpendicular to each other at the correct intervals.

Although the other two services, as well as the AEC, are doing work

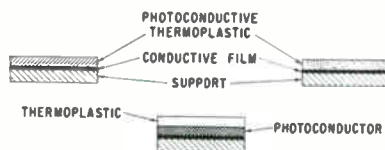
in this area, Army spokesmen indicated the Picatinny installation will be the largest and most complete of its kind. A conference on Hero (Hazards of Electromagnetic Radiation to Ordnance) techniques will be held in May at the Franklin Institute in Philadelphia.

Electrostatic Film Erases

TECHNIQUE for producing dry-processed pictures in 0.1 to 0.01 sec by focusing a light image on an electrostatically charged photoconductive plastic film has been developed by General Electric.

Military applications—such as immediate display of radar images by a projector—will see first use of the technique, according to Joseph Gaynor of GE's Advance Technology Laboratory, inventor of the process. PPR may make pos-

TWO-INCH Section of picture that has been recorded twice on the same film. First image was erased



PHOTOPLASTIC layers of film may be transparent or opaque

sible "instant X-ray or even X-ray movies," Gaynor said.

PPR reportedly produces grainless pictures that can be developed and erased by heating the film. Up to 144 photos can be produced in a 2-inch square. The film is reusable, can be made either sensitive or insensitive to nuclear radiation, clear or opaque.

The charge on the photoconductive film is dissipated when light strikes it, but is retained under the dark portion of the image. After the film is softened by heating, microscopic depressions are formed in it by the electrostatic charges—conforming to the pattern of the image. The film is then cooled to seal in the depressions.

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Wideband Communications Is Army

Outcome of feasibility studies will determine big procurement program

WHAT IS EXPECTED to develop into the Army's largest communications procurement depends on the outcome of the three one-year feasibility studies of the Rada system (Random Access and Discrete Address) awarded last month (ELECTRONICS, p 8, March 29). Rada may displace all other switched communications used in Army divisions.

The companies receiving contracts, each for almost \$2 million,

are Martin Marietta, Motorola and RCA. What Army wants is a wideband system in which many users would share a common band.

An Army source said Martin was selected on the basis of its work on Racep (Random Access and Correlation for Extended Performance). This system (ELECTRONICS, p 64, Oct. 26, 1962) handles up to 700 subscribers over a single 4-Mc channel and permits direct dialing. Voice and data transmissions can be handled simultaneously. Martin says that it will continue development of Racep and will also be working on other techniques.

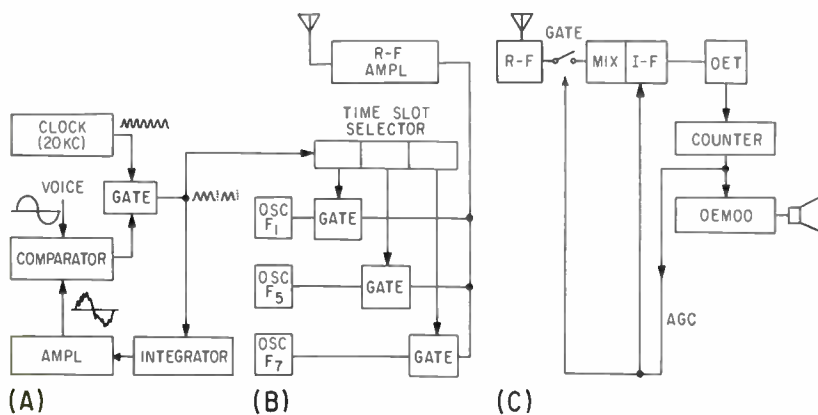
An RCA spokesman this week declined to reveal information on the techniques RCA is considering,

stating that company and military clearance had not yet been obtained.

Motorola reports it has developed techniques that would permit thousands of talkers to use a single uhf-vhf channel. Delta modulation samples voice analog waveforms and converts them (see diagrams) into a train of 26- μ sec pulses, or to no pulse. A time-slot selector in the transmitter tags each bit with a discrete address. Every modulation pulse is transmitted by three or four bursts of carrier, 0.5 μ sec or longer. Changing the spacing between pulses and frequency selection of bursts offers several thousand different time-frequency-pattern addresses.

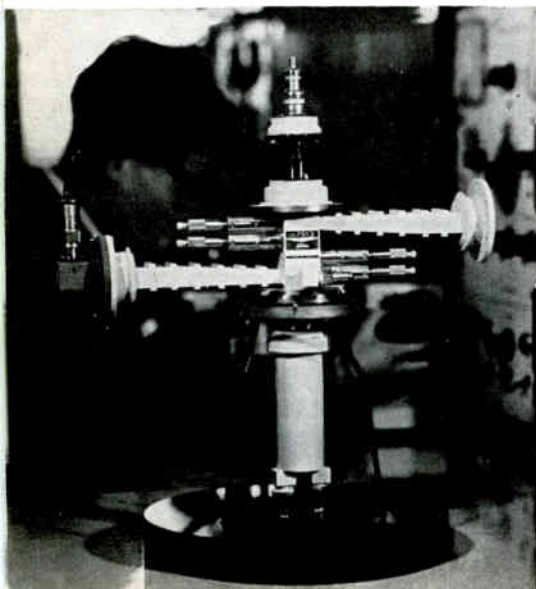
Address recognition precedes the demodulator in the receiver. Discrete addresses gate the preset time slots at the previously chosen frequencies, Henry Magnuski, Motorola's associate director of research, explained to ELECTRONICS. A counter monitors this operation.

Magnuski said the elimination of tuning and frequency control circuits means the wideband equipment would cost one-third or one-half as much as narrow-channel variable frequency equipment covering the same frequency spectrum. Integrated circuit techniques are especially suited to this type of digital operation, he added. Frequencies in the 150 to 450-Mc range



DELTA MODULATOR in Motorola concept (A) feeds coded voice to the transmitter (B). At right is the receiver (C)

IEEE Show: Less Life, More Service



NEW YORK—Much of the razzle-dazzle of past IRE Shows was missing last week at the IEEE Show. The tone of this year's show was reflected in the lack of glamorous—as opposed to salable—equipment at the Coliseum.

Where visiting engineers used to see huge antennas rotating on pedestals, monkeys in space capsules and exhibitors dressed as

spacemen, only the pretty models reminded one of flashier shows.

On the other hand, the caliber of sales engineering rose. Exhibitors concentrated more on getting to know customer problems. The model was often supplanted—or replaced—by an engineer with a nomograph.

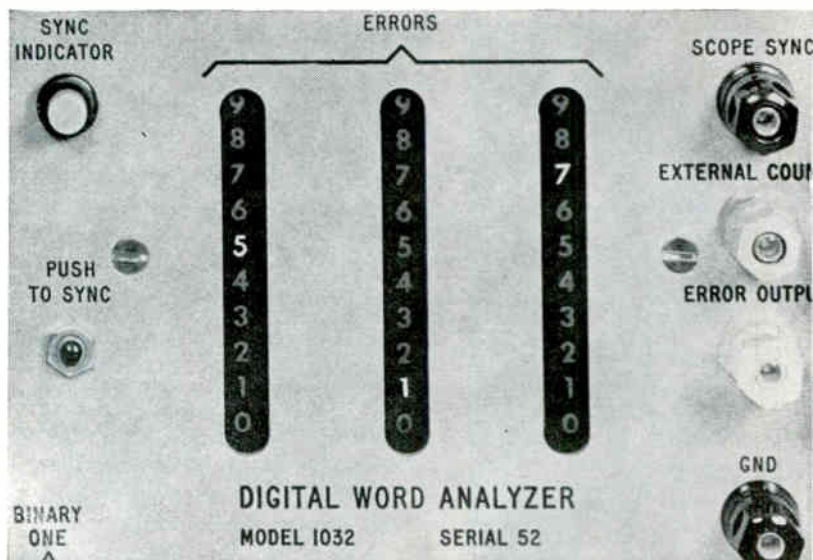
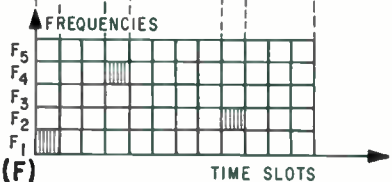
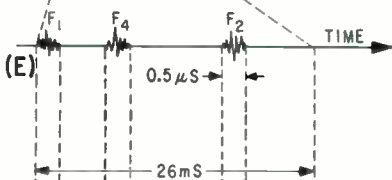
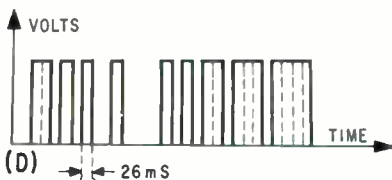
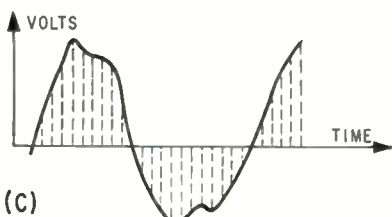
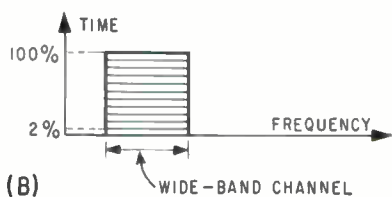
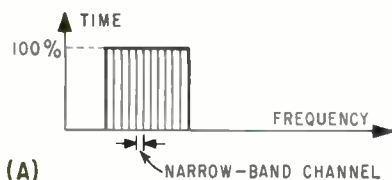
MORE NEW PRODUCTS—In addition to its new annular process transistors (ELECTRONICS, p 7, March 29), Motorola Semiconductor Products introduced a new silicon gate-controlled switch that can be turned on and off by pulses of op-

WIDEBAND, four-resonator, c-w klystron for space communications system. Toshiba tube puts out 3.5 Kw, has gain of 34 db and is tunable able between 6,340 and 6,440 Mc

Plan

would provide a wide spectrum, localize radiation and avoid skips. Motorola also sees as a likely civilian application mobile telephony at 700 to 900 Mc.

UNLIKE narrow-band systems (A), Motorola's assigns wideband channels (B). Sampled voice waveform (C) is converted to digital (D). Addressed r-f signal is shown in (E) and the time-frequency matrix in (F)



For Sale: Machine Talk

Data transmission systems periodically require testing, trouble shooting, and evaluation, and two extremely valuable instruments for system checkout are Rixon's model 132 Digital Word Generator, and model 1032 Digital Word analyzer.

The Word Generator provides a repetitive digital word in length up to 32 bits for transmission through the system. The Word Analyzer at the receive location generates an identical word, comparing this with the received word. Discrepancies between these two words are totalized by a three digit error counter and visually displayed on the front panel of the analyzer. Other features?

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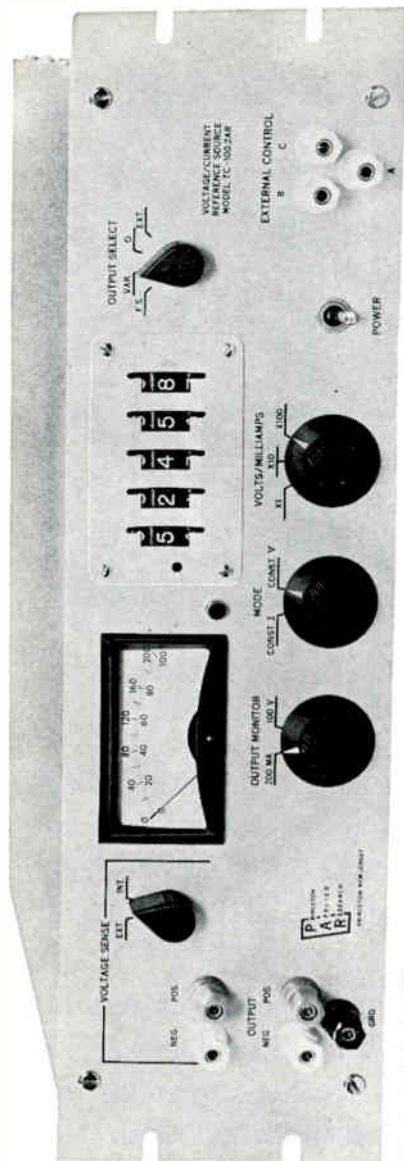
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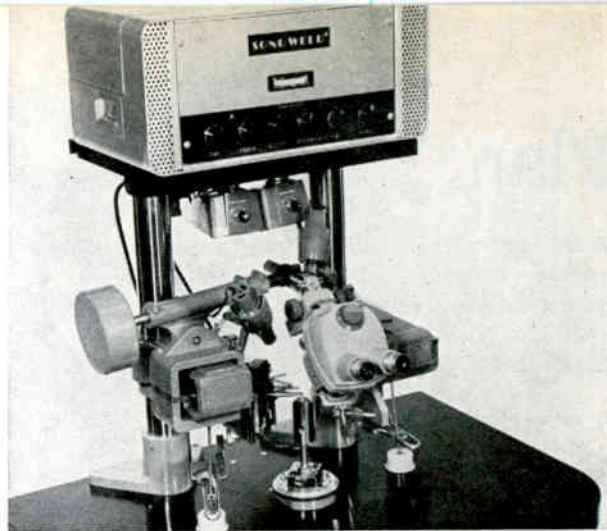
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Write for Bulletin No. 105



ULTRASONIC welder, by Sono-bond, is combined with Kulicke & Soffa micropositioner. Dual settings allow two different combinations of metals to be welded



posite polarities. Another new one is an epitaxial-base germanium transistor for tv flyback circuits and similar applications.

A cuprous-chloride light modulator making possible low-power, high-frequency modulation of laser beams and a dysprosium-doped calcium-fluoride c-w laser crystal were displayed among RCA's electro-optical devices.

Allen-Bradley entered shift registers and matrix switch modules using reed switches, for industrial control applications.

EQUIPMENT — Pulse-generator module by Texas Instruments Incorporated has a rise and fall time adjustable from 20 to 500 nsec, pulse width from 40 nsec to 1 msec, and pulse delay from 90 nsec to 1 msec. Applications in computer design and semiconductor research are anticipated.

A complete dual-channel parametric amplifier subsystem, designed for troposcatter front ends, was shown by Airtron division of Litton Industries. Frequency is 4.4 to 5 Gc, system noise figure 3.5 db maximum, instantaneous bandwidth 25 Mc and gain 17 db min.

A solid-state printer that uses flux reversal of magnets to control cam hammers was shown by Monroe Calculating Machine. It operates on a four-line coded input, prints 1,040 lines a minute.

PRODUCTION GEAR—Universal Instruments had an axial-lead component sorter that also orients the parts and straightens leads. It automatically sorts capacitors, inductors, resistors and diodes according to impedance.

Several precision welders were shown. One, by Taylor-Winfield,

uses a two-stage electrode-force setup aimed at eliminating erratic results when copper lead wires are welded to nickel ribbon. Automatic prevention of excess force is also a feature of Sippican's welders.

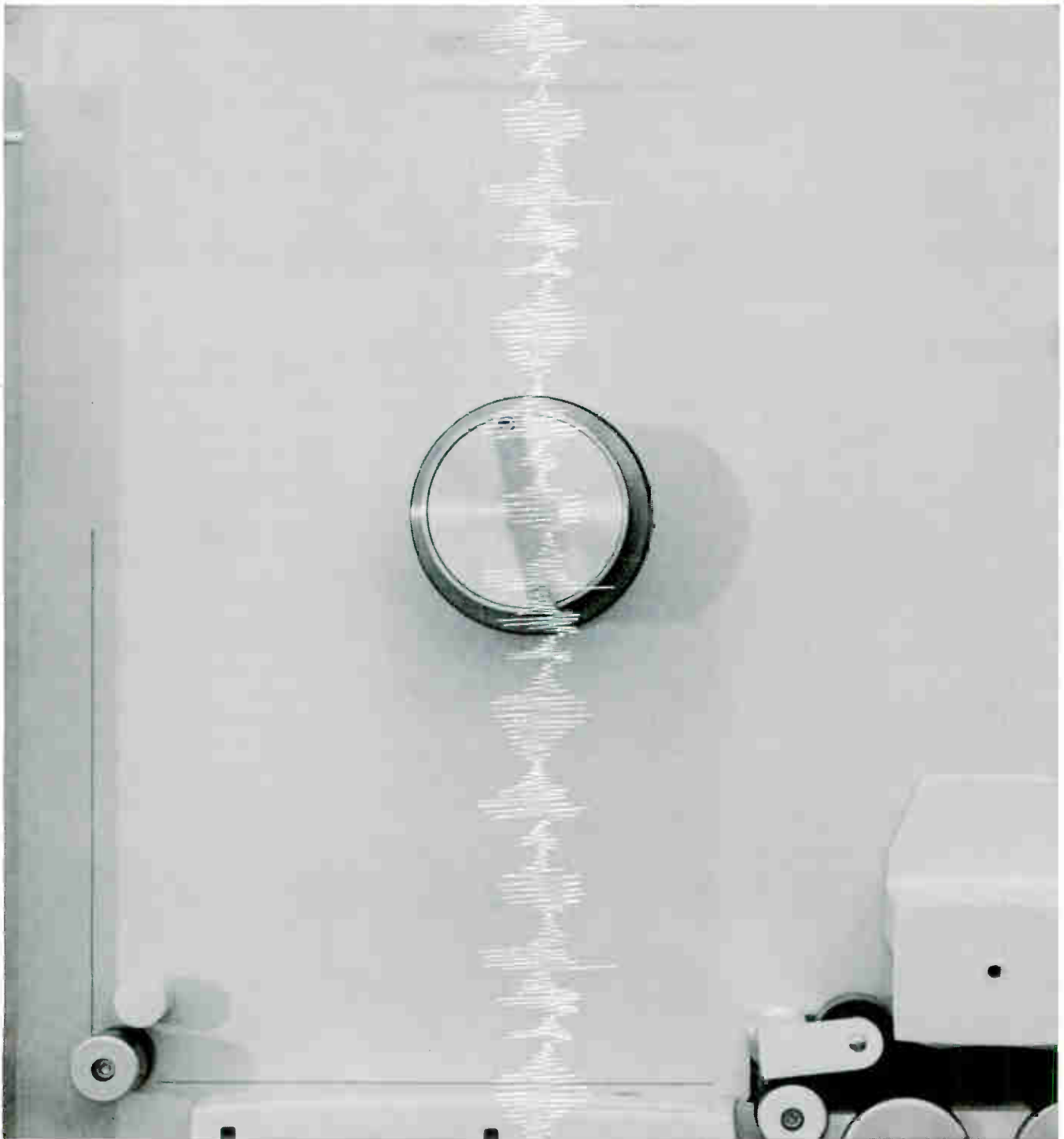
In a Norton Company machine, thin steel reciprocating blades and fine abrasive slice through quartz, silicon, germanium and glass. Wafers produced are parallel within 0.0005 inch and kerf loss is as little as 0.006 inch, Norton says.

JAPANESE EXHIBITORS—Toko Radio Coil Laboratories showed a woven memory matrix, made up of insulated wire and wire coated with a thin layer of ferromagnetic material. Weave crossover points serve as memory elements. Readout speed is 80 msec, operating temperature up to 150 C. This kind of memory has also been developed in the U. S. (ELECTRONICS, p 59, June 29, 1962).

Toshiba's slow-speed tape recorder records up to 6 hours on a 5-inch tape reel at a speed of 1 1/2 inch per second. Sony's new video tape recorder uses standard 2-inch tape with an added layer of molybdenum that extends magnetic head life. New 5-lb tv camera, shown by Nippon Electric, has a 1-inch vidicon, can be battery operated.

CITIZENS BAND 25 to 30-Mc receiver puts out 1 mw, has 1/2-mile range. Receiver is at right, 6-v power supply at left. Westinghouse Air Arm division built it with four standard integrated-circuit functional blocks





Who has both: 1.5 Mc recorder and 1.5 Mc tape?

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We just don't like to leave things undone. Recently, our engineers developed the first 1.5 Mc per track, multi-track recorder—the FR-1400. Like every Ampex recorder, it gives you outstanding performance. We felt we had to develop a tape that equalled the FR-1400 in quality of performance. Hence: Ampex 9101—a 1.5 Mc tape. This new tape is a high resolution, heavy duty type with excellent wear characteristics. It offers high reliability



and superior performance. And can record 1.5 Mc of data at a speed of 120 ips. Ampex 9101 tape rounds out a recording system that gives you the highest frequency in longitudinal recording today. For more information write the only company providing recorders, tapes and memory devices for every application: Ampex Corp., 934 Charter St., Redwood City, Calif. Worldwide sales and service.

AMPEX



EAST GERMANY shows two parallel-connected Endim 2000 analog computers



STUDIO TV CAMERA from Poland can be remotely controlled

WEST STILL LEADS EAST IN ELECTRONICS

By RICHARD MIKTON
McGraw-Hill World News

East's prototypes are advanced, but they are behind in gear produced

BONN, GERMANY—East Bloc electronics manufacturers showcased a wide variety of new developments at the 1963 Spring Trade Fair in Leipzig, East Germany, last month. Some of the designs are surprisingly advanced, but these are mostly prototypes or still in development. Most of the equipment in production is outmoded by Western standards.

East Germany appears to lag the West by 5 to 10 years in the computer field, as do most East Bloc countries. The one exception is the USSR, whose new Ural model is said to be equivalent to recent Univacs. Nor is the East up to the West in electronic components.

Trading between East and West at this year's fair was less than in previous years. Of the 2,000 or more Western exhibitors, only a handful showed electronic equipment. The Westerners explained that although the East wants to buy, it is short on Western currency. Western firms are not enthusiastic about bartering computers for nails or minerals.

EAST-WEST TRADE — Several Western exhibitors displayed punched-card equipment. Only two British firms made significant sales. Elliot Automation reports a contract for some \$500,000 with Poland for the National 315. International Computer & Tabulator will sign a \$250,000 contract with

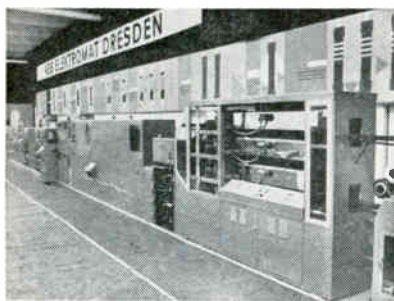
East Germany as a result of the Fair.

Remington Rand's Dutch subsidiary reported much interest in Univac computers by Eastern governments. This year, it displayed only punched-card equipment, but a spokesman said they hope to have a Univac 1004 on display next year. Machines Bull of Paris reported lower interest due to currency shortages.

COMPUTERS—East Germany has decided to rely on Russian and Western computing equipment because she is short of electronic components and know-how. Despite this, three models were on display: the ZRA-1, which performs about 250 operations a minute, the recently developed analog computer Endim 2000 and a small program-controlled desk model.

Poland displayed a new general-purpose digital computer, called the ZAM-2. It uses the Polish-developed symbolic address system SAS and the SAKO autocode to speed programming. Word length is 36 bits, working storage is 1,024 short words, with an average access time of 0.36 msec. An auxiliary magnetic-drum storage permits 16,384 long words to be stored. Average operating speed for addition and subtraction is 1000 operations/sec, for multiplication and division 260 operations/sec. The printer and other accessories come from Western suppliers, including Ferranti.

AUTOMATION PLANS — East Germany plans to increase electronics production by 360 percent between 1963 and 1970. Emphasis



WESTERN OBSERVERS were surprised by the quality of this East German line for automatically producing resistors. Three people run it



STANDARDIZATION of panels and components is new look in East German equipment



POLAND'S ZAM-2 digital computer is slow by Western standards

is being placed on standardizing components and their production in highly automated equipment.

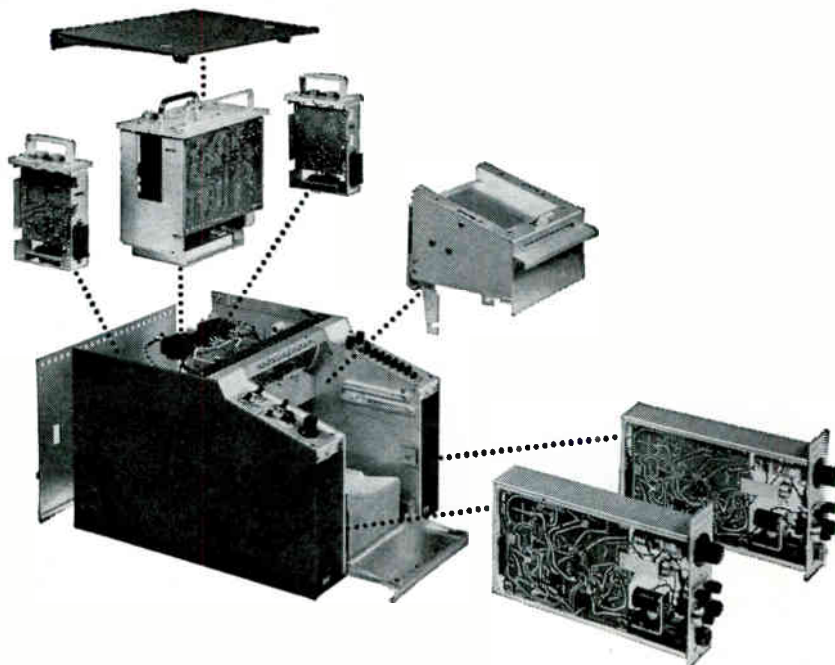
Panels and related components on scientific and technical apparatus are now standardized. Conventional printed circuits, three-dimensional elements and micromodules are still in the prototype stage, but plans are to produce standard sizes automatically.

Typical of emphasis on automation was a new automatic line for the production of $\frac{1}{2}$ -watt carbon-coated resistors at 2,500 an hour.

TRANSISTORS — East German progress in transistors is retarded by Western standards because of reliance on tubes. Mass-produced transistors now have a frequency limit of 100 Mc. Mesa types for up to 1 Gc are expected for laboratory use sometime in 1964. Power transistors up to 4 watts are now being produced. The first silicon transistors of the state-run Institute for Transistor Development were exhibited, but no production data was available.

TV CAMERAS — East German products included an 11-lb tv camera, an infrared vidicon and a new directional beacon set that permits transmission of 600 telephone calls or one tv signal including audio. The Poles showed a new series of tv studio cameras that can be remotely controlled, industrial tv systems, and a variety of other tv station gear.

In all, there were 9,000 exhibitors at the show. The bulk—about 6,000—were East German firms. Other East Bloc countries were represented by 250 trade missions.



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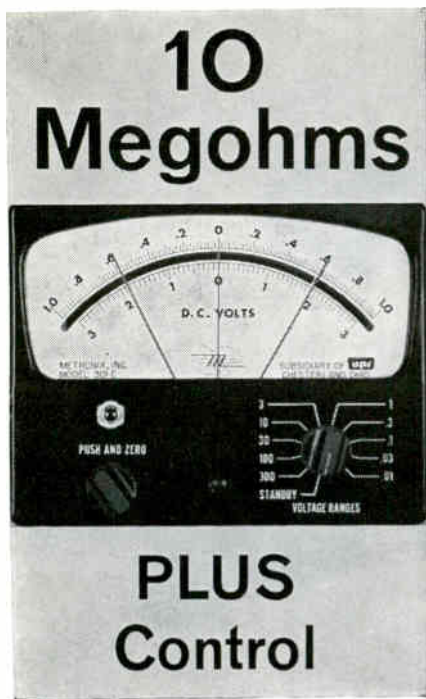
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Will Lasers Settle Down?

Brilliant engineering needed before "playboy" is workhorse, says panel

NEW YORK—Although the era of unexpected breakthroughs in lasers is not yet over, the vital need now is for engineering—straight-forward, brilliant and interdisciplinary. This was the consensus of an IEEE panel discussion Tuesday night on "Optical Maser—Workhorse or Playboy?"

An effective combination of workers in electronics, quantum mechanics, optics and spectroscopy is needed for further development, said Charles H. Townes, MIT provost and panel moderator.

Robert H. Kingston, of MIT Lincoln Laboratory, reported that government supports about \$15 million of laser work a year, and industry \$5 million to \$10 million. Some 40 percent of the funding goes for devices and techniques, 25 percent for materials study, 20 percent for prototype applications, 10 percent for optical components and 5 percent to find new materials. He estimated 600 to 700 scientists and engineers are working in the field.

NOT COMMUNICATIONS?—Rudolph H. Kompfner, of Bell Telephone Laboratories, disagreed with claims that communications will be the laser's most important application, pointing out the atmospheric attenuation problem. But he said lasers could be useful in space and, if shielded by pipes, in earthbound applications. However, the laser can communicate in the plasma sheath while microwaves cannot. He indicated that efforts are being made to use lasers—even diodes operating in a noncoherent mode—for reentry communications.

"But it is really useless to talk about systems until component techniques are worked out," he added.

PROCESSING AID—Arthur L. Schawlow, of Stanford University,

thought that the laser's most important application ultimately will be probing and processing chemical reactions.

George F. Smith, of Hughes Laboratories, predicted that among other uses will be emission spectroscopy. He cited work at Jarrell-Ash Co., where Frederick Brech is identifying material traces down to 10⁻¹¹ gram.

Townes saw promise in seismography and meteorology. The surface of a parabolic antenna can be measured to one wavelength, "but in the present state of technology we don't know what to do with that degree of accuracy."

See Hospitals Buying Patient-Monitor Devices

AVERAGE HOSPITAL operating room may soon require \$100,000 in patient-monitoring equipment, predicts John E. Jacobs, professor of electrical engineering at Northwestern. There are about 7,000 hospitals in the U.S. Jacobs also sees a potential market of \$1,000 per hospital bed for such devices.

Tv Camera Unveiled



LOW-COST vidicon tv camera introduced by General Precision at this week's meeting of the National Association of Broadcasters in Chicago features 8-inch viewfinder and 6,000 to 1 automatic light compensation

MEETINGS AHEAD

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

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

RADIATION DAMAGE TO SOLAR CELLS SYMPOSIUM, IEEE-PTGED; Statler-Hilton Hotel, Washington, D. C., April 10-11.

OPTICAL MASER SYMPOSIUM, Electrochemical Society; Penn Sheraton Hotel, Pittsburgh, Pa., April 15-16.

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

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

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

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

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

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

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

POWER INDUSTRY COMPUTER CONFERENCE, IEEE; Westward-Ho Hotel, Phoenix, Ariz., April 24-26.

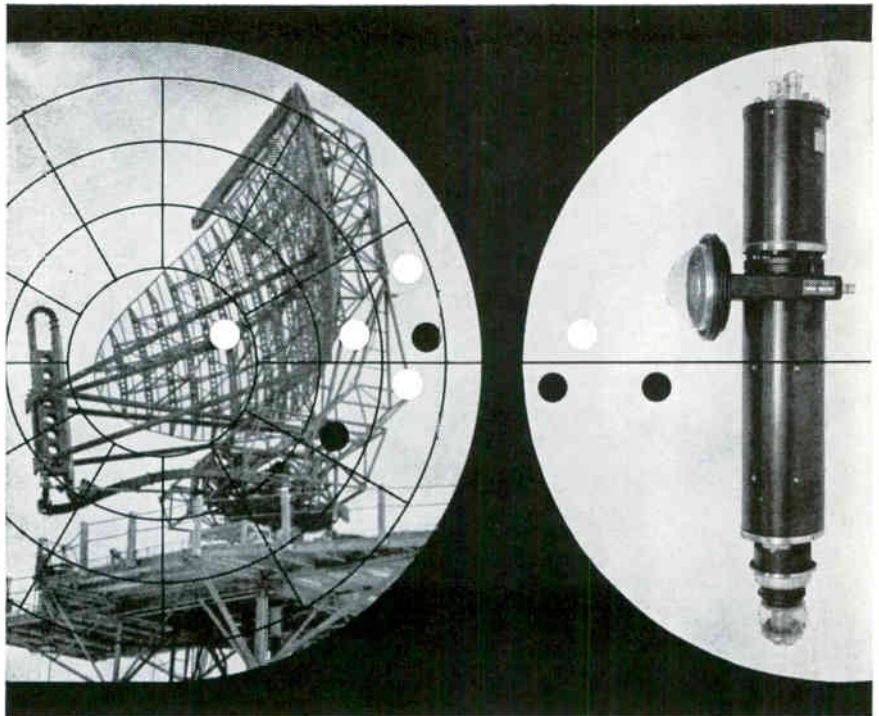
WESTERN ELECTRONIC SHOW AND CONFERENCE, WEMA, IEEE; Cow Palace, San Francisco, Calif., Aug. 20-23.

ADVANCE REPORT

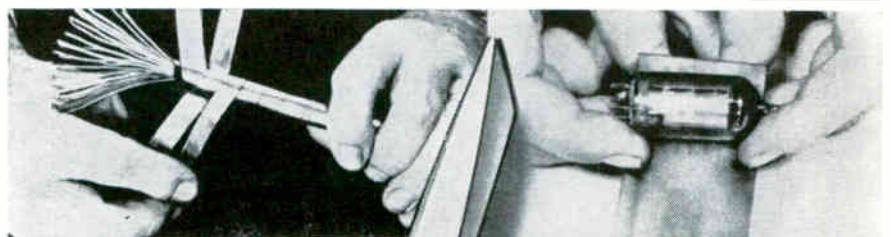
NATIONAL SPACE ELECTRONICS SYMPOSIUM, IEEE-PTGSET; Hotel Fontainebleau, Miami Beach, Fla., Oct. 1-3. April 15 is deadline for submitting 500-word abstract to: Dr. H. Nelson Uphengrove, PGSET Technical Papers Chairman, Bell Telephone Laboratories, Whippany, N. J. Papers describing original investigations and developments in following areas are solicited: space communications; electronics and space environment; electronics for interplanetary missions; electronic aids for men in space; electronics in unmanned spacecraft; electronics for command guidance and control.

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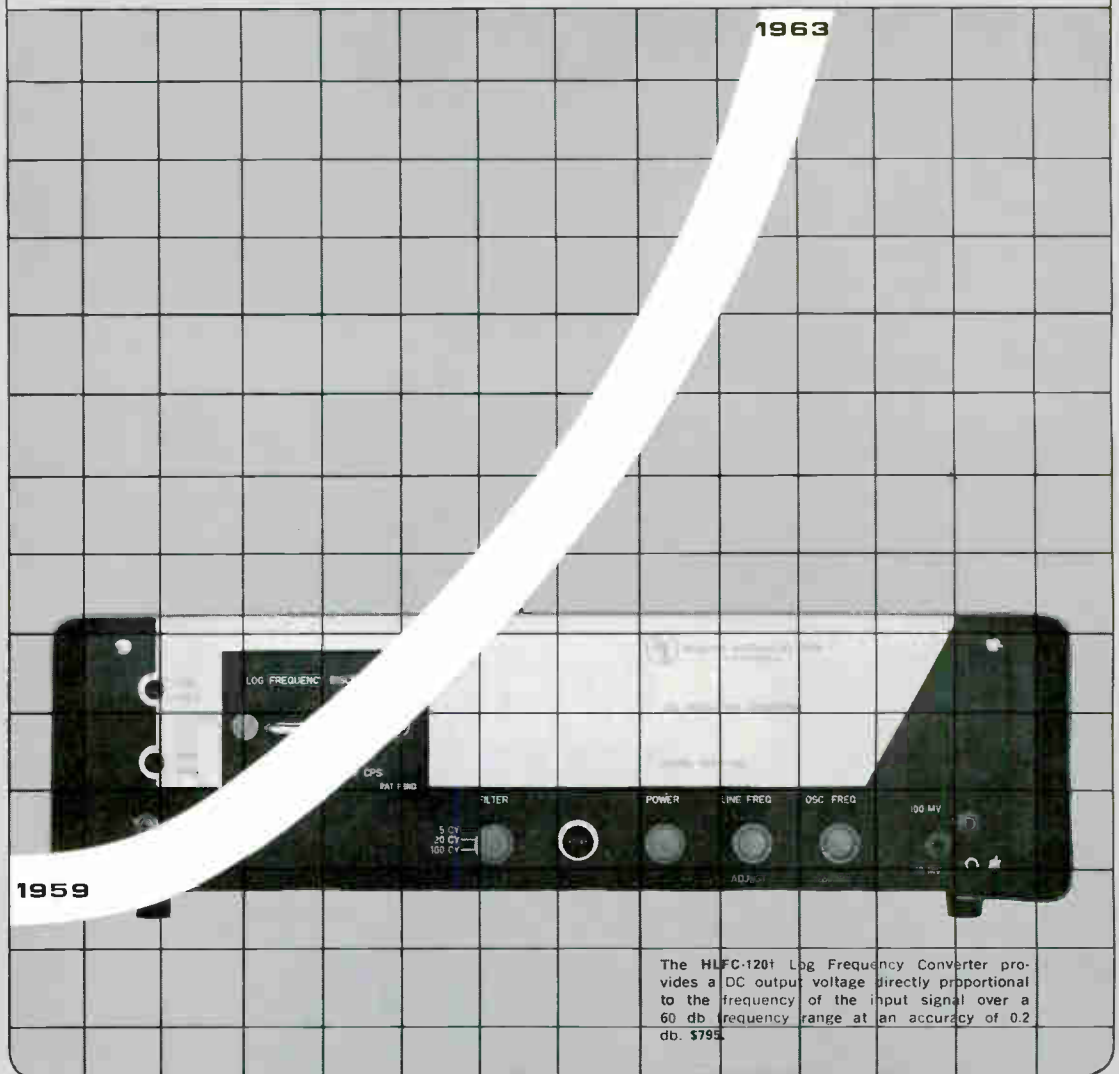
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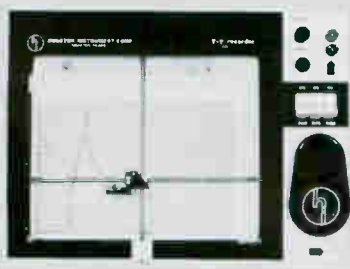
The HR-95 Recorder, a high performance 8½ x 11" recorder featuring plug-in modules and dual regulated zener reference supplies. Front recording panel swings open for easy access to all of the electrical and mechanical components. \$1250.

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Emphasizing a straightforward design approach, the HR-97 is an 11 x 17" XY recorder with 1 mv/in. basic sensitivity, 0.25% of full scale accuracy, 15 in/sec. pen speed, zener reference voltages, snap-on pen assembly and vacuum paper hold-down. \$1350.

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The HR 80 T-Y* recorder provides rectangular recording as a function of time on standard graph paper of any variable expressible as DC voltage. \$475.

* TM Houston Instrument Corporation



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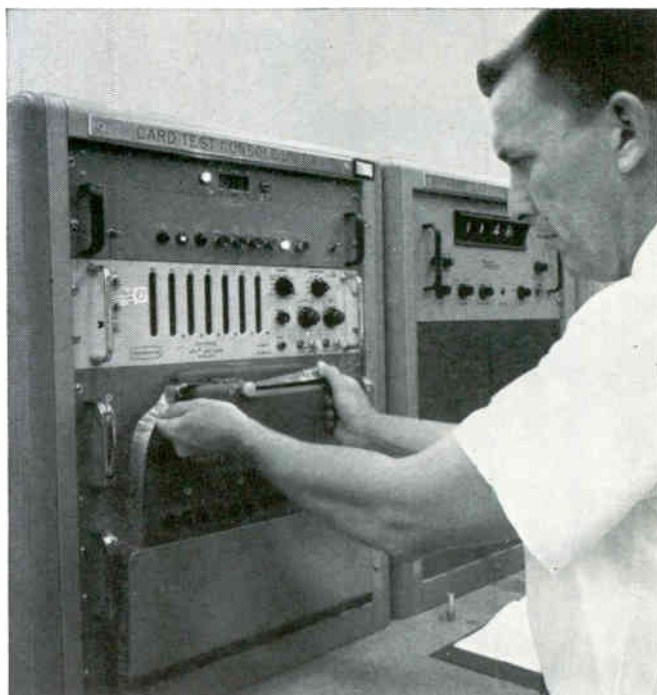
Engineers of the Martin Company have developed an automatic card testing machine that electronically inspects printed circuit cards used in the firm's PERSHING, BULLPUP, GAM-83 missile systems as well as its air defense and communications systems. Key to the speed, simplicity and cost savings of the machine is the EI Digital Multimeter which displays test results of the tape program at the push of a button!

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Carle W. Collins, production test engineer, Martin Company's Orlando (Fla.) Division, inserts coded Mylar tape into the reader unit of the Tape Programmed Automatic Tester which he designed.



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ARMY is deploying the AN/GRC-106 transistor vehicular ssb transceiver. This unit has excellent stability through the use of a frequency synthesizer



MILITARY RADIO Swinging To SSB

Single sideband has been growing up during the last decade. Today the mode is important in military communications. It permits smaller, lighter equipment and increases mobility.

Here are some reasons why

By BARRY A. BRISKMAN Assistant Editor

THE COMPLEXITY and speed of today's military operations requires a speedup in communications. In radio systems, this means an increase in efficiency, reliability and the simplification of equipment.

During the last decade, single sideband has become important in military communications. It affords advantages of small size and low weight of transmitters and power supplies as well as high readability under irregular propagation conditions. United States military services are switching to ssb systems



SSB AND THE AIR FORCE

Single sideband is of vital importance to today's air defense. It has proven itself again and again in both communications effectiveness and reliability. Moreover, the simplification of airborne ssb equipment has done much to eliminate human error where we can least afford it. Militarily, the mode has a bright future.

Francis H. Griswold
Lt. General, USAF

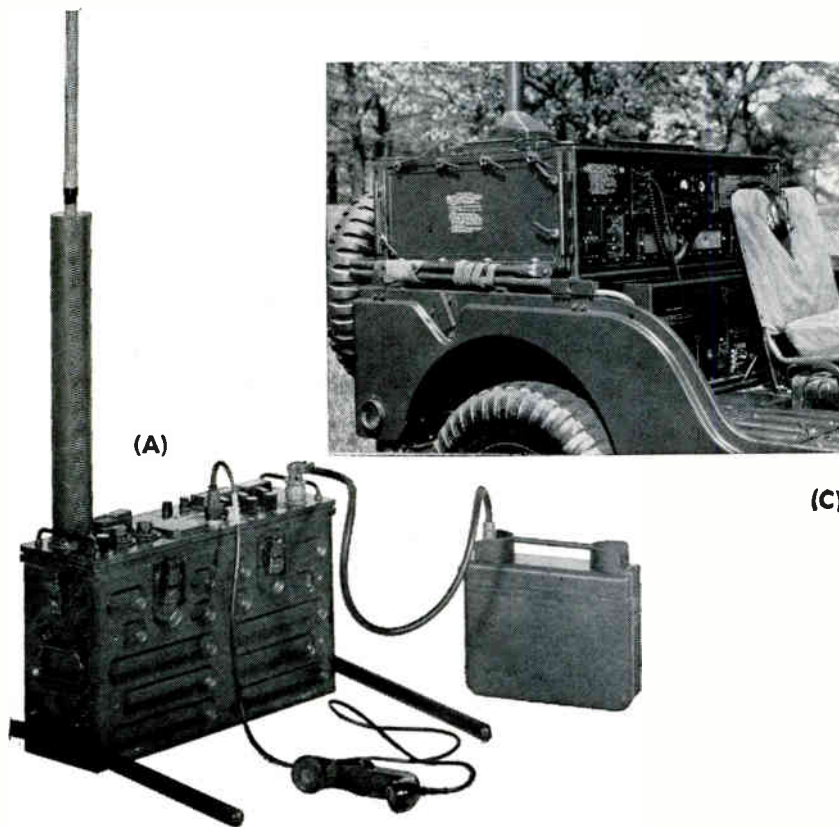
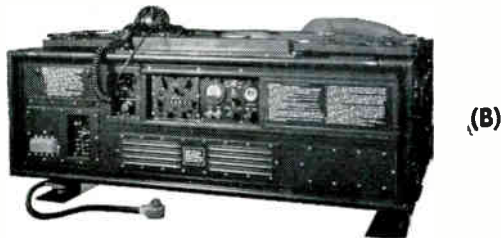
for many of their high-frequency communications needs. For example, Army and Air Force use single sideband widely for airborne and front line radio.

WHY?—While single sideband cannot accurately be called a distinct form of modulation, it does have spectral-energy distributions and wave-forms that are different from f-m and conventional a-m. Reduced bandwidth requirements are important to the military, since they desire to make maximum use of a limited spectrum to perform a given communications function. The narrow-band characteristics of ssb permit channel splitting on nearly a two-to-one basis, and the nature of the mode increases reliability by reducing splatter, unwanted beats and phase distortion due to fading. Moreover, reduced bandwidth in ssb receivers enhances noise discrimination, a factor of importance where radio equipment is used in vehicular and airborne environments.

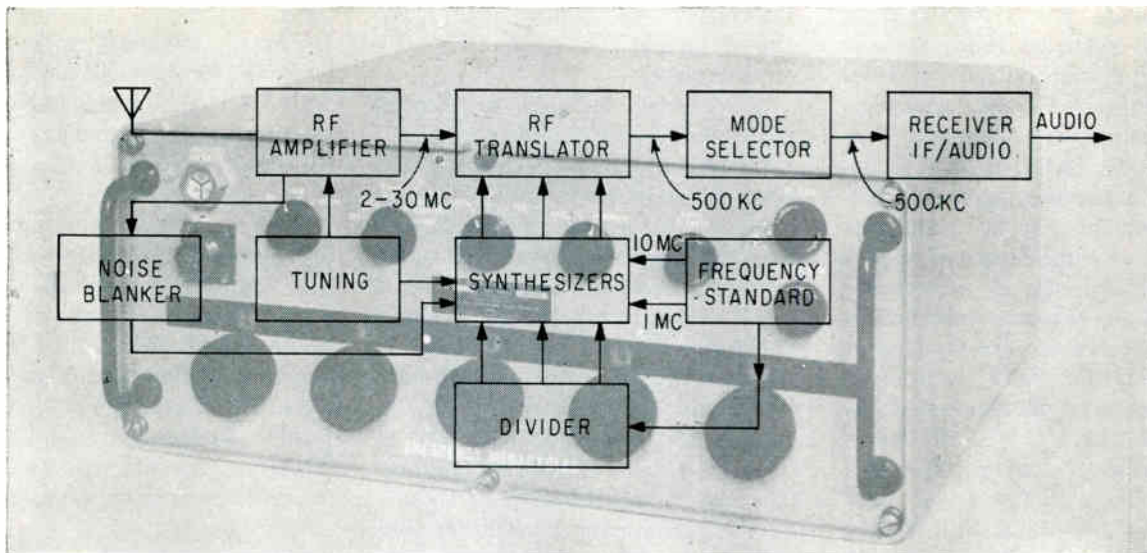
Except for fixed, point-to-point use, most military radio systems cannot use large, high-gain antenna systems. When rudimentary radiators such as simple whips and dipoles are used, transmitters must have high efficiency and power output to successfully accomplish their missions. Requirements for high mobility mean that loss of antenna gain cannot be compensated for with larger equipment; many ssb systems are now operational that occupy as little as $\frac{1}{4}$ the space of an a-m or f-m unit that could accomplish the same military function.

The use of semiconductors and computer techniques in ssb systems now permits military equipment to have high frequency-selecting accuracy. Digital readout for new ssb equipment reduces operator errors and substantially simplifies equipment operation.

AIR FORCE—According to Major General John B. Bestic, ex-Director of Telecommunications of the Strategic Air Command and present Deputy Director of the National Military Command Systems, ssb has had a significant impact on Air Force high-frequency communications. General Bestic says that while multichannel, multiplex ssb



PACKSET AN/PRC-47 is an ssb transceiver with 100 watts output between 2 and 12 Mc (A); AN/TRC-75 can deliver 900 watts pep output at any 1-Kc increment between 2 and 29,999 Mc (B); the AN/TRC-75 can be mounted on an M38A1 jeep to form the AN/MRC-83 mobile system (C)—Fig. 1



TRANSCEIVER SC-901X weighs only 47 pounds. This unit has a frequency synthesizer and consumes 75 watts in the transmit position—Fig. 2

systems have been functioning in commercial and military systems for years, many dramatic advances accredited to ssb have taken place in high-frequency, single-channel voice systems.

Military high-frequency voice systems have been greatly extended with the advent of ssb; SAC has switched to single sideband for airborne h-f radio communications and has an elaborate point-to-point network in use for urgent operational needs. In addition, Tactical Air Command has changed to ssb and airways communications stations of the Air Force Communications Service have followed suit. Moreover, new production aircraft with h-f radio requirements are production-line equipped with single sideband.

General Bestic says that "The dramatic conversion to single sideband is the result of three primary factors. Carrier suppression gave ssb its initial boost in system reliability by providing a most sizable increase in talk-power over conventional amplitude modulated transmitters of comparable input power. This increase in power was accompanied by other benefits like a decrease in equipment weight and size, a substantial saving in input power and a reduction in the power-handling tolerances of individual components". He continues by saying, "The end result can best be illustrated by comparing the standard airborne transceiver with the

equipment it replaced. The 1,000-watt ssb unit requires one-third less space than its 100-watt a-m predecessor".

"As I see it, the increases in the effective power obtained by converting the old a-m carrier into effective sideband talk-power is the key to the Air Force success with ssb. Side-by-side tests between comparable a-m and ssb units have proven the superiority of single sideband under marginal propagation conditions. Signals that were unreadable on the a-m systems were communications quality when transmitted over the same path by ssb. Moreover, a substantial economy has been effected in frequency conversion by eliminating the unwanted sideband. Particularly on the lower frequencies, we have been able to split old-single-channel a-m frequencies into two ssb channels", says General Bestic.

The Air Force has pointed out that problems of frequency calibration, tuning and loading had made the operator essential, but that with the development of more stable oscillators and error sensing devices, automatic tuning and loading is now an Air Force way of life. Airborne tuning equipments now consist of digital frequency displays, a sideband selector and a volume control. All these factors contribute to simplicity of operation and often eliminate the need for the airborne radio operator-technician. Simple digital computer circuits tune equipments

with six, single-conductor wires from the pilot's position. Savings in payload in operator elimination plus added flexibility and convenience obtained by locating the equipment remote from the pilot, may have more than paid for development costs.

General Bestic also feels that along with human engineering in the airborne field, similar developments have taken place in the ground system. Operator skills have been advanced by simplified automation and technical development—translated into tremendous flexibility in the ground environment.

Direct radio relay between ground stations has become increasingly common. Strategically placed stations (illustrated by the SAC commanders' net) using ssb systems are now, to a large extent, independent of propagation conditions. Signals are relayed from ground station to ground station when conditions prohibit direct point-to-point contact from originating station to destination, providing the calling and called parties the same service as direct, point-to-point radio contact.

These factors hold true for all the military branches. Some observers feel that almost 90-percent of all h-f military communications functions will be by single sideband within the next ten years.

ARMY — Front-line communications dependability is important for

ground forces. Equipment such as the walkie-talkie or radio packset have been revolutionized by sideband techniques. A modern man-carried transceiver is shown in Fig. 1A. This unit (AN/PRC-47) is designed for a two-man team and provides dependable, tactical communications plus a high degree of battle-front mobility. It is alternately suitable for vehicular installation and can be powered directly from a storage battery. This transceiver operates on any 1-Kc increment between 2 and 12 Mc with 100 watts pep (peak equivalent power) output on either upper or lower sideband or c-w and has a total weight of only 40 pounds. World War II packsets weighed as much or more, and seldom exceeded 25 watts output using a-m or f-m systems.

Transceivers with power outputs up to or greater than 1,000 watts pep, are also designed for front-line, vehicular use. The AN/TRC-75 pictured in Fig. 1B can be installed on a M-38A1 jeep as shown in Fig. 2C, to form a flexible mobile communications system. This ssb transceiver will deliver 750 or 900 watts pep output on upper or lower sideband, c-w, fsk or compatible a-m, on any frequency between 2 and 29.999 Mc.

Both the AN/TRC-75 and AN/PRC-47 have excellent frequency stability and resetability under battle conditions. These features are achieved with frequency synthesis techniques that provide up to 28,000 separate automatically tuned channels that are presented digitally. The application of frequency synthesis to ssb equipment has fulfilled military requirements for bet-

ter-than-crystal stability even when the equipment is operated in hostile environments.

The Army recently announced that it has standardized on the AN/GRC-106 transistor vehicular ssb transceiver shown in the lead photograph of this article. This unit is a 400 watt pep ssb transmitter and a superhet receiver contained in a small and lightweight (100 pound) package. It will provide reliable communications over a 50-mile range with modest antennas and is capable of worldwide coverage if used with more effective radiators. The unit is half the size and weight of the transceiver it replaces and provides ten times the effective signal power of the old set. The AN/GRC-106 is capable of operation on any one of 28,000 rapidly selectable channels. The exact operating frequency appears digitally on its front panel.

Sophisticated mobile com centers such as the AN/MRC-87 provide 1,000 watts or more output between 2 and 30 Mc and also include vhf and uhf ssb facilities at reduced power. These systems can be expanded to handle powers up to 10 kw and often include as many as five separate radio stations for simultaneous, multiband operation.

Figure 2 shows the completely transistor SC-901X ssb transceiver that operates between 2 and 30 Mc with 28,000, 1-Kc channels having a stability of 1 part in 10^7 per week. Though only $17 \times 18 \times 7$ inches and 47 pounds, this unit contains a complete ssb transceiver plus a frequency synthesizer, and consumes only 75 watts in the transmit posi-

tion. Harmonic and spurious responses, unwanted sideband and carrier are down 50 db, and image and i-f rejection are 80 db down. A functional block diagram of the SC-901X appears in Fig. 2.

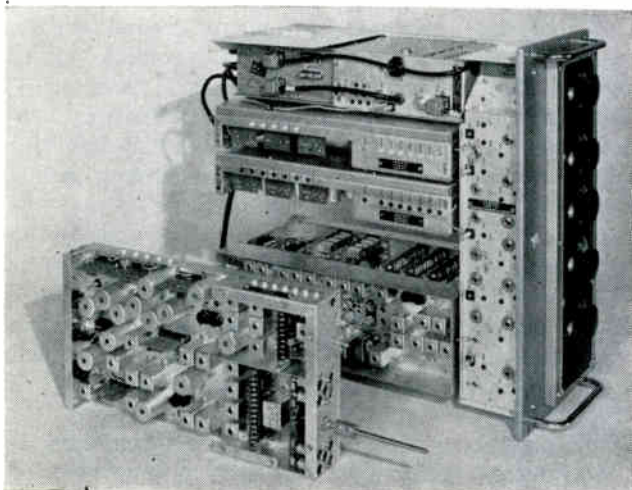
NAVY — Naval communications equipment has also been affected by the transition to single sideband. Many ships now use ssb for communications between land and sea stations on low and high frequencies. Naval aircraft equipment contains sideband transmitters and receivers for aircraft to land and aircraft to ship applications.

OUTLOOK—Single sideband has added a substantial increase in versatility to military communications equipment. The dissemination of government contracts for the design and development of ssb equipment and systems is on the upswing. For example, expanded airborne requirements have generated R&D contracts that will result in still smaller and lighter high-power ssb transceivers that attain complete coverage of the spectrum between 2 and 30 Mc with frequency-standard stability. The complex equipment required for precise frequency control is being manufactured by many companies here and abroad. A typical synthesizer is shown in Fig. 3.

Many contracts call for the design and production of uhf ssb equipment. New, high-linearity transmitting tubes, coupled with high stability oscillators and improved methods of generation, are making ssb equipment for the gigacycle ranges practical.

Advances in linear amplifier tubes are permitting high-power tubes to assume a smaller silhouette. Many new types are of ceramic-metal construction and have external fin-type anodes for increased plate dissipation. As a direct result of improvements in transmitting tubes, linear amplifiers are appearing that require less space than a typical buffer stage in the 100-watt transmitter of 15 years ago.

Engineering advances commensurate with increased requirements for ssb equipment should continue to result in widespread circuit and component improvements, for even higher efficiency and reliability.



FREQUENCY CONTROL is now often accomplished by frequency synthesis. This Marconi unit is also typical in that it has modular construction—*Fig. 3*

Tunnel Diode Detects Currents Down to 100 Femtoamperes*

Attribute testing of reverse leakage currents in semiconductor diodes and transistors is one of many applications of this low-level current detector

By **CARL DAVID TODD**

Head of Engineering, Modular Circuits Dept.
Hughes Aircraft Co., Newport Beach, Calif

LOW-LEVEL currents can be measured directly or compared by a simple circuit that uses the negative resistance characteristic of a tunnel diode. The economical current detector, which has measured currents of 0.1 picoampere, provides rapid recovery from overloads. Detector output is in binary form and may be a voltage, closure of a relay or the lighting of a lamp.

Low-level current instrumentation has become increasingly important for measuring some of the parameters of the improved silicon semiconductor devices that have become available. Measuring small currents is also a basic requirement in such other areas as nuclear electronics.

Currents below 1 nanoampere are

AUTHOR TODD uses simple tunnel-diode circuit to make low-level current measurements

* NEW UNIT

1 femtoampere = 1×10^{-15} ampere

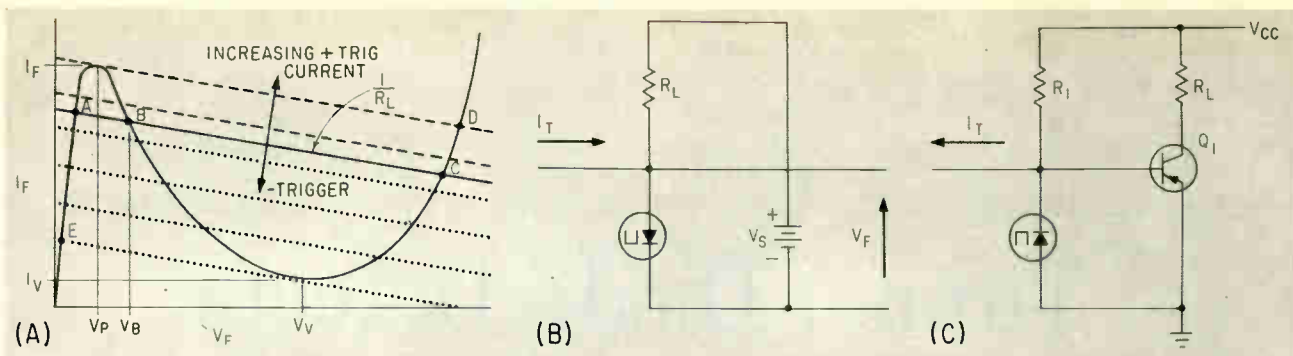
covers rapidly from overloads can be designed using a tunnel diode as a threshold triggering device and also as a memory.

TUNNEL DIODE SWITCH — The tunnel diode can easily be biased for bistable operation because of its negative resistance characteristic. The load-line conditions are shown in Fig. 1A, where points A and C correspond to the two possible states. When operating at point A, voltage drop across the tunnel diode is typically only about 30 mv. During operation at point C, the voltage drop is about 450 mv for a germanium device.

If the tunnel diode in the circuit in Fig. 1B is operating at point A, operation can be switched to point

usually measured with relatively expensive electrometers. However, this expenditure is often difficult to justify, particularly when measurements are on an attribute or go no-go basis. In addition, recovery of these instruments after severe overloads is often intolerably long. A simple current detector that re-





C by momentarily increasing current through the diode above peak current I_p . Similarly, operation can be switched back to point A by supplying a negative trigger current that reduces current through the tunnel diode below valley current I_v . Because of the general shape of the tunnel diode characteristic curve, much less energy is required to switch from A to C than from C to A.

Switching can be initiated either by applying a trigger current as indicated or by switching a capacitor across the tunnel diode that has been charged in the correct polarity to a sufficient amplitude. The energy requirements are such that the initial voltage must slightly exceed V_n . If shunt capacitance across the tunnel diode is appreciable compared to the triggering capacitance, the initial voltage must be sufficient to charge all capacitance shunting the tunnel diode and still exceed V_n .

Thus, if operation was originally at point A and the triggering capacitor has been switched across the tunnel diode, measuring the voltage across the tunnel diode determines whether the initial charge was adequate and of the correct polarity to switch the state of the tunnel diode.

TRANSISTOR AMPLIFIER—Using the simple tunnel diode switch, the change in output voltage is small and output power is not adequate for many applications. A transistor can be added to provide output at a more useful level, as shown in Fig. 1C. Operating conditions are shown in Fig. 2D, where characteristics of the emitter-base junction of the transistor and those of the tunnel diode are shown in the composite curve.

If the second bias point on the composite curve falls close to I_v of the tunnel diode, most of the bias

current will flow in the transistor base in Fig. 1C. When operating at point A in Fig. 1D, base current is practically zero so collector current is small. However, when operation is switched to the conditions at point C, substantial base current flows, and collector current is $h_{FE}I_B$. Thus, even with a 1-milliampere tunnel diode, 50 ma or more can be switched in the collector circuit. In addition, the voltage swing can be as large as the transistor will permit.

SIMPLE CURRENT DETECTOR

—In Fig. 2A, capacitor C_1 charged by unknown current I_x can be connected directly across the tunnel diode by closing switch S_1 . If the tunnel diode is in the low-voltage state and if the initial voltage exceeds V_n in Fig. 1A, switching will be initiated. If I_x were in the opposite direction to that shown, the polarity of the voltage across C_1 would not cause the desired switching.

Closing S_2 resets the tunnel diode back to the low-voltage state. If S_2 is closed before S_1 is released, the capacitor will be fully discharged. If S_1 and then S_2 are released, after time t_1 , the charge on C_1 can again be used for interrogation.

The charge on the capacitor is

directly related to the value of the capacitor, current I_x and the time between complete reset and interrogation. Assuming that I_x is constant with time, the relationship is

$$V_{C(t)} = I_x t_1 / C_1 \quad (1)$$

Eq. 1 can be rearranged to indicate the value of I_x required to produce voltage V_B that is adequate to switch the tunnel diode to the high-voltage state

$$I_x = V_B C_1 / t_1 \quad (2)$$

A typical value of V_n for a germanium tunnel diode is 85 mv. Assuming a value of 120 picofarads for C_1 and allowing t_1 to be 1 second, I_x need only be 10 picoamperes. By extending the charging time to 10 seconds, 1 picoampere can be detected.

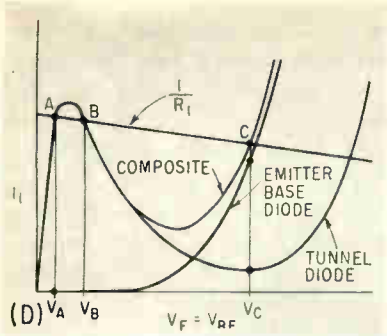
A transistor amplifier can be added to the circuit in Fig. 2A to drive a lamp that indicates directly operation of the tunnel diode in the high-voltage state.

TRANSISTOR SWITCHING

—Switches S_1 and S_2 in Fig. 2A can be replaced with transistors so that the interrogation and reset operations can be controlled by appropriate pulse sequences, as in Fig. 2B. For the polarities shown, S_1 must be replaced by an npn transistor for interrogation. The collector leakage current that flows

APPLYING NEWER COMPONENTS

Many new devices have become available to the electronics engineer in recent years. They usually cost more than conventional components. Their behavior under a wide variety of conditions is not always completely understood. When is their use in circuits justified? The new device may enable a circuit to perform its intended function better. Its use may simplify the circuit, improve reliability, lower overall costs. Here is a group of circuits using the tunnel diode to detect low-level currents that meets all of these criteria and more



TUNNEL diode can operate in two stable states (A) with suitable biasing (B). Transistor amplifier (C) provides useful output under conditions shown in curves (D)—Fig. 1

SWITCHING operating states of tunnel diode (A) can be done with transistors (B)—Fig. 2

when Q_1 is off must be much less than unknown current I_x . The base of Q_1 is therefore driven negative during the off state so that leakage current will be slightly less than I_{cbo} . Even with the best transistors, basic detector sensitivity is limited by leakage current, which is about 1 nanoampere and depends heavily on temperature.

Switch S_2 could be replaced directly with a *pnp* transistor, although the slightly modified reset circuit in Fig. 2B provides some additional advantages. The bias resistor for the tunnel diode has been replaced by two separate resistors— R_1 and R_2 . With the collector of Q_2 connected to the junction of R_1 and R_2 rather than directly to the tunnel diode, the transistor need not be driven into saturation for adequate reset. In addition, shunt capacitance associated with Q_2 is removed from the tunnel diode.

The switches in Fig. 2A may be manually operated, although control of timing will be somewhat poor except for longer periods. A control circuit can be used to obtain the desired sequence of closure and release. Relays can replace the switches, or the circuit in Fig. 2B may be used.

Although both S_1 and S_2 must be closed to reset the circuit completely, the tunnel diode memory will be reset if only S_2 is closed. After the tunnel diode has been switched to the high-voltage state, capacitor C_1 will not discharge fully. In fact, it will normally continue to charge to a voltage equal to V_F in Fig. 1D. This voltage would be adequate to assure triggering of the tunnel diode on the next interrogation even if I_x had dropped to zero.

Because of the switching sequence required for the circuit in Fig. 2A, the output signal (indicating that the memory has been set)

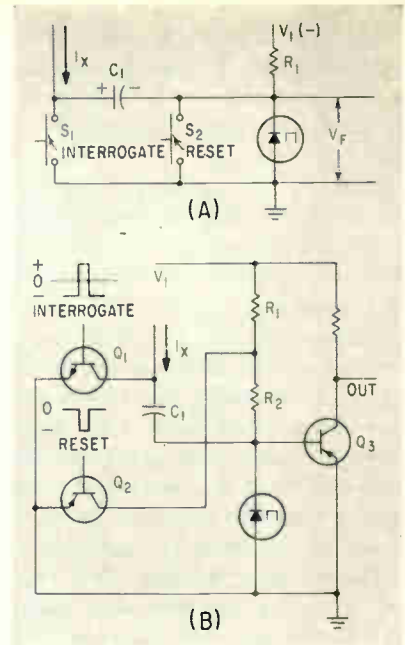
may not be present during the charging cycle. However, the required control sequence can be greatly simplified by making a minor modification in the circuit.

In the circuit in Fig. 3A, the triggering capacitor is isolated by a diode rather than being connected directly to the tunnel diode. If the capacitor is adequately charged in the correct polarity, it may still trigger the tunnel diode. However, as soon as the tunnel diode has switched to the high-voltage state, coupling diode D_1 is reverse biased and the voltage across C_1 cannot be increased by the tunnel diode. With diode D_1 in series with the tunnel diode, C_1 must be charged to an appreciably higher level of about 200 to 300 mv. Although this can be provided, basic detector sensitivity will be reduced.

If interrogation is continued after the tunnel diode has been triggered (S_1 remains closed), C_1 will begin discharging through resistor R_2 in Fig. 3A. Thus, interrogation during reset is no longer necessary to assure discharge of C_1 .

With the simplified control arrangement, the circuit can be interrogated, which also discharges the capacitor, and then reset just before the next interrogation. The output thus indicates the state of the memory throughout the charging cycle and reflects the integrated current that has flowed during the last charging cycle. For the memory to remain set, I_x must adequately charge the capacitor during each charging cycle.

COMPLETE UNIT—A practical low-level current detector and memory unit is shown in Fig. 3A. When a negative input pulse is applied to Q_1 , the transistor drives relay K_1 , which performs the interrogation. A dry-reed relay is used to provide



adequate speed with low leakage current.

Diode D_1 isolates trigger capacitor C_1 from the tunnel diode after it has been triggered, and R_2 assures adequate discharge of C_1 during the latter portion of the interrogation period. A negative pulse applied to the base of Q_2 causes the transistor to reset the tunnel diode. Transistor amplifier Q_3 drives a lamp to indicate that I_x has been of sufficient amplitude and correct polarity to trigger the tunnel diode memory. If desired, a relay or resistor may be substituted for the lamp.

The circuit in Fig. 3A requires the two pulses in the prescribed sequence for interrogation and reset. Pulse widths are generally not critical if the reset pulse is followed shortly by the interrogation pulse. Time between interrogation pulses should be controlled since it affects detector sensitivity.

CONTROL UNIT—The circuit in Fig. 3B provides the control pulses in the proper sequence to the detector and memory unit in Fig. 3A. Basic timing is accomplished by a silicon unijunction transistor operated in a relaxation oscillator circuit. For a given unijunction transistor, the period between pulses is determined by the product $R_3 C_2$. Thus, to change basic sensitivity of the detector, it is only necessary to change R_3 or C_2 .

As C_2 is charged through R_3 to the level where Q_1 is triggered, a

pulse is fed to the base of Q_5 , which causes it to conduct heavily. With Q_5 on, capacitor C_3 charges toward the supply voltage level through D_2 , and simultaneously a reset pulse is developed across R_1 .

While C_3 is charging, there is little forward drop across D_2 because it is biased in the forward direction. However, as soon as the pulse produced by Q_4 disappears and transistor Q_5 is switched off, C_3 produces a reverse bias across D_2 so that a relatively large negative pulse is fed to the base of Q_6 . Normally, Q_6 is saturated and collector-emitter voltage is practically zero. However, as the negative pulse is applied to the base, Q_6 is switched off and collector voltage rises rapidly, providing the necessary negative pulse to drive the interrogation circuit.

LIMITING—In many applications, it is important that the current detector recover rapidly from a temporary overload. Although the circuit in Fig. 3A provides relatively fast recovery, especially for large positive values of I_x , limiting can improve recovery time after overloads of either polarity. Two basic approaches can be used to limit the effects of large currents in this circuit: a current-limiting device can be connected in series with the input or some form of shunt limiting can be used.

If the source of the unknown current is assumed to have a high output resistance, as is often the case, inserting a resistor in series with the input in an attempt to limit current will have little effect. How-

ever, the relatively constant current characteristics of a semiconductor diode biased in the reverse direction can be used. A typical characteristic curve is shown in Fig. 4A. If current through the limiting diode in the reverse direction is considerably less than I_1 , voltage drop across the diode will not be significant. However, as current through the diode tends to increase beyond I_1 , voltage drop across the diode becomes larger. If a diode is chosen with a breakdown voltage larger than the voltage compliance of the unknown current source, input current to the detector will be limited to about I_1 .

The type diode is determined by the level of current being measured. A good silicon diode limits current to about 1 nanoampere at room temperature. This level can be increased by using devices with larger areas. Germanium diodes can limit current to about 1 microampere. Two diodes connected back to back can be used for series limiting of currents of either polarity.

In a shunt limiting circuit connected directly across the input, silicon diodes could limit input voltage to about 0.6 or 0.7 volt. Therefore, this approach might be used at high current levels. However, even a silicon diode conducts when it is forward biased only a few hundred millivolts. If the current is larger than I_x , the circuit will not operate.

Two shunt diodes can be connected across R_2 in Fig. 3A to limit maximum voltage applied to the tunnel diode through D_1 . The diodes will not conduct until the interrogation period and even then the

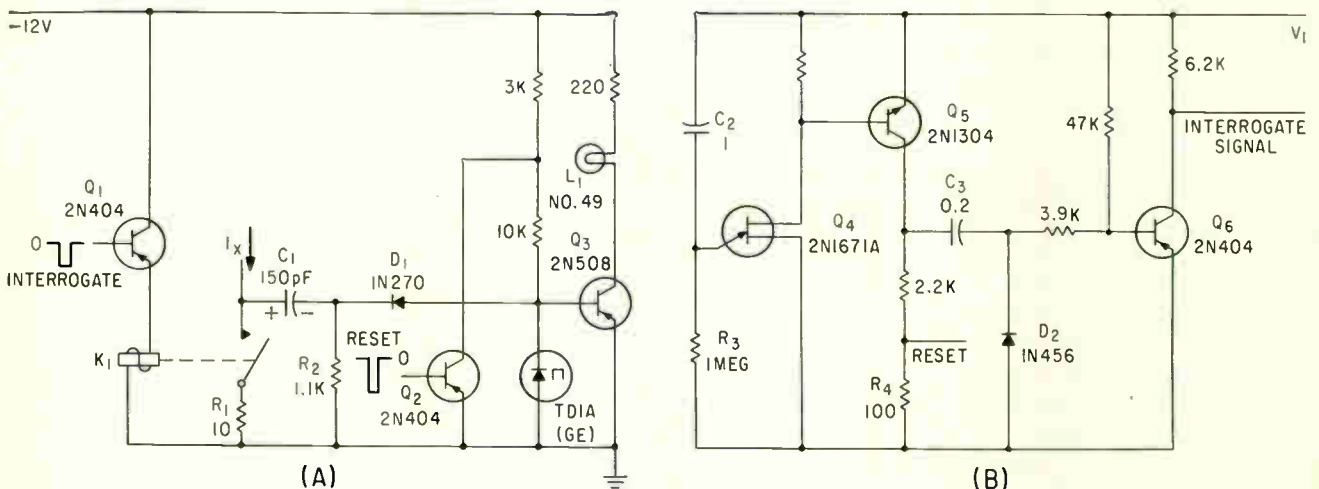
current will be small. This arrangement has little effect until an overload occurs except for the added capacitance, which need not be large.

With input voltage clamped by the diodes, the detector circuit usually recovers during the interrogation pulse and is ready immediately for the next measurement. The small resistance of R_1 in series with the interrogation relay limits peak current after an overload.

APPLICATIONS—The low-level current detector can be used to measure current directly. The current is simply injected at the input terminal. If the unknown current is large enough to charge the triggering capacitor adequately, the tunnel diode memory will be set by interrogation and lamp L_1 in Fig. 3A will be switched on.

The triggering threshold, and hence the magnitude of I_x required to set the memory, is a function of temperature primarily because of the variation in the voltage drop across D_1 . Thus, if accurate discrimination is required over a range of temperatures, the circuit must be compensated to reduce the threshold variation.

The low-level current detector can also be used as a current comparator by making its sensitivity much greater than the value of the unknown current. A negative reference current is summed with the unknown current, and the detector is used to determine whether I_x is larger or less than the reference by detecting the polarity of the summed currents. Resolution de-



LOW-LEVEL trigger and memory unit (A) is provided with pulses (B) by control circuit—Fig. 3

depends on sensitivity of the detector circuit and may be made less than 10 picoamperes if required.

Another application of the low-level current detector is attribute testing of reverse leakage currents in semiconductor diodes and transistors. A typical test configuration is shown in Fig. 4B. The limit of current that can be tested is determined by V_1/R_1 . If V_1 is not well enough regulated to provide the necessary precision in the reference current, a voltage regulating circuit can provide the necessary drive for R_1 . Close regulation of overall supply voltage is not usually necessary.

If leakage current through the transistor junction is less than the reference current, net current I_x into the input terminal will be negative, the memory will not be triggered, and the lamp will remain off. However, if I_{cbo} exceeds reference current I_y by the design threshold value of the detector, the memory will be set by each successive interrogation and the lamp will glow.

A simple but excellent attribute test set is thus provided by the circuit in Fig. 4B. The reject limit can be controlled by varying either R_1 or the voltage applied to R_1 . It is possible to test to a limit of 1 nanoampere. In addition to its basic simplicity and high accuracy, by using series limiting in the detector, no further limiting is required to protect the transistor or diode under test against the possibility of test voltage exceeding breakdown voltage.

A similar arrangement can be used for testing leakage resistance in switches, relays, capacitors and printed circuits. Large resistances can be tested on an attribute basis without subjecting the device under test to the high voltages encountered in many high resistance testers. Avoiding these higher voltages is especially important where voltage-sensitive devices are used in parts of the circuit.

The test circuit used for attribute measurement of high resistances is shown in Fig. 4C. Negative voltage supply V_1 produces current through standard resistor R_s that opposes current produced through unknown resistance R_x by positive voltage supply V_2 . When resistance R_x is high enough so that net current entering the detector is either nega-

tive or below the positive threshold value, lamp L_1 remains off. As R_x decreases, a point is reached where I_x equals the threshold value and is of the correct polarity to set the tunnel diode memory and cause L_1 to glow. The mathematical relationship governing threshold resistance R_{XT} is

$$R_{XT} = R_s(V_2 - V_T) / (I_T R_s + V_1 + V_T) \quad (3)$$

where I_T is threshold current of the detector and V_T is detector input voltage under threshold current conditions.

When threshold voltage V_T is insignificant compared with V_1 and V_2 , Eq. 3 reduces to

$$R_{XT} = V_2 R_s / (I_T R_s + V_1) \quad (4)$$

If the detector current threshold limit is made low compared with current flowing through R_s , the relationship can be further simplified to

$$R_{XT} = (V_2 / V_1) R_s \quad (5)$$

which indicates the case where the magnitudes of V_1 and V_2 are made equal. In this case, the threshold value of R_x is equal to standard resistance R_s .

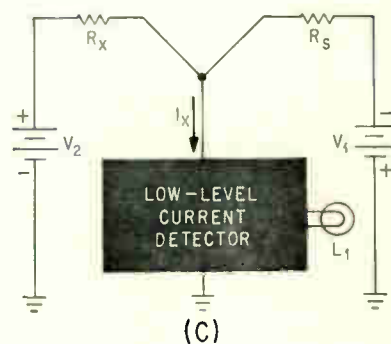
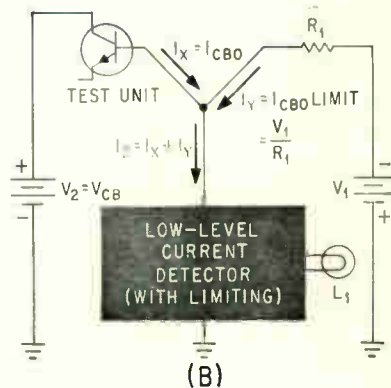
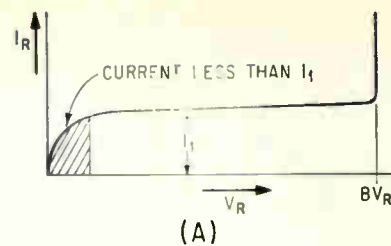
Using this technique, leakage resistances of about 10^{12} ohms can be measured with reasonable accuracy and speed using only 28-volt supplies.

In the equations given thus far, it has been assumed that I_x remained constant during charging time. For the more general case in which I_x may vary with time

$$V_{C(t)} = \frac{1}{C} \int_0^t i_x dt \quad (6)$$

Thus, the actual triggering threshold condition depends on both time and current. Therefore, a detector can be made that responds to the current value integrated over a period of time, which can be controlled by modifying the control circuit to interrogate on command of an external synchronizing signal.

MEASURED RESULTS—The basic circuit in Fig. 2A has been used to measure a current of 0.1 picoampere, using carefully cleaned components and a charging time of about 1 minute. The circuit in Fig. 3A with the control circuit in Fig. 3B has been used to measure currents of about 1 picoampere, again using carefully cleaned components but with a charging time of about 10 seconds. With charging time reduced to 100 milliseconds so that

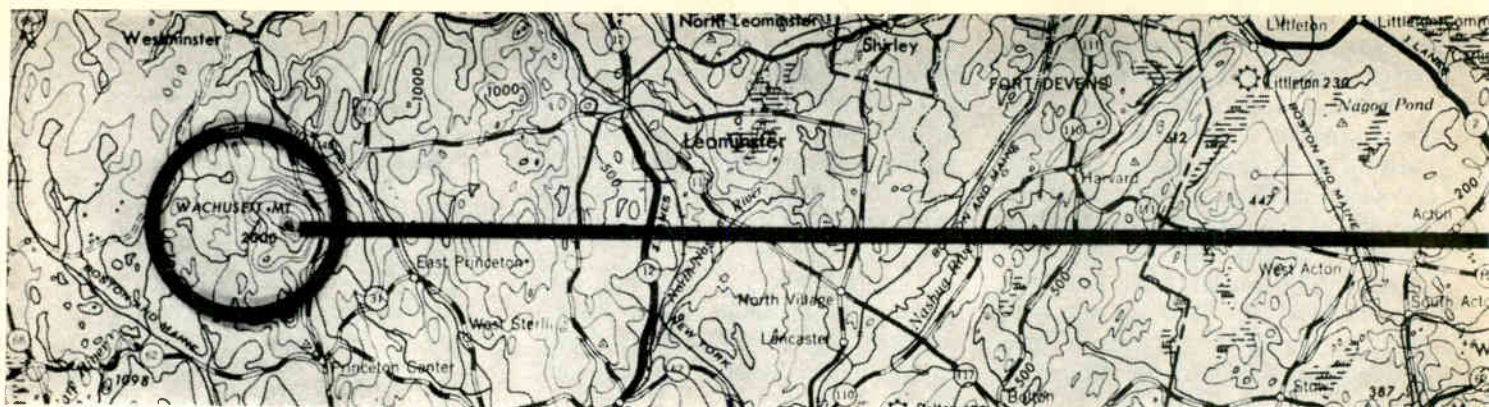


CHARACTERISTIC curve (A) indicates current-limiting effect of semiconductor diode. Low-level current detector can be used for production testing of transistors (B) and high-resistance measurements (C)—Fig. 4

10 readings are taken each second, currents less than 300 picoamperes were sufficient for reliable triggering.

Using 1-second timing and a threshold of 10^{-10} ampere, the circuit was tested for severe overload. With no limiting, overloads exceeding 10:1 caused no problems regardless of polarity. Overloads exceeding 100:1 would not trigger the memory because of ringing in the tunnel diode circuit.

A simple shunt limiter consisting of two diodes placed across R_x in Fig. 3A made the circuit relatively immune to overloads of 1 million to 1. Recovery usually occurred within one or two interrogation periods, and the lamp always indicated the proper relationship of threshold to unknown current.



MAP showing the 30 nautical-mile line-of-sight path from Mt. Wachusett, Princeton, Mass., to Lincoln Laboratory,

NOW OUT OF THE LAB

Modulated Infrared Diode

Modulated light sources for communication are being applied to practical systems. Here is how the infrared emissions from a GaAs diode have permitted audio and video signals to be sent and received over a path that is 30 nautical miles long

By R. J. KEYES, T. M. QUIST, R. H. REDIKER, M. J. HUDSON, C. R. GRANT and J. W. MEYER
Lincoln Laboratory*, Massachusetts Institute of Technology, Lexington, Mass.

WITH the development of each new source of electromagnetic radiation, a host of applications occur to communications engineers plagued by the problems associated with more familiar regions of the spectrum. Not the least of these, is increasing congestion in the radio and microwave bands and the resultant shortage of allocations therein.

Other problems are overall conversion efficiency from prime to radiated power and the complications encountered in the impression of information on the carrier.

Recombination radiation from semiconductors offers a source of remarkable efficiency that is simple to modulate. Moreover, its spectral width is very narrow, even for incoherent operation. This latter feature permits the use of narrow-band filters that discriminate against background grey-body noise.

IMPLICATIONS—According to the communications range equation, $R_{max} = K (P_T G_T A_R / P_R)^{1/2}$, where K is a proportionality factor including those characteristics of the system not explicitly expressed by P_T , the power of the transmitter; G_T , the transmitter gain; A_R , the effective area of the receiver aperture and P_R , the minimum power required at the receiver input to do the job at hand.

The optical equivalent of the effective radiated

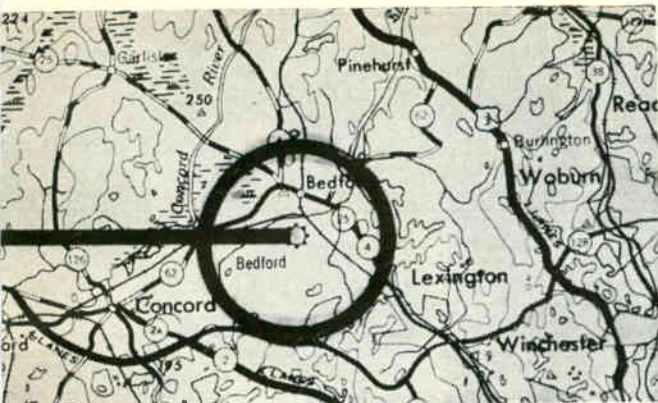
power $P_T G_T$, shows the effectiveness of the transmitter optics in concentrating the source power into a narrow beam. Except for propagation effects and the differences in receiver sensitivity, it appears that the wavelength used makes little difference. Propagation effects, however, such as scatter and scintillation, are so strongly dependent upon the vagaries of weather and other environmental conditions such as smoke and haze, that these effects can be only roughly estimated. Thus, the proof of this promising technique required a test demonstration. This experiment was just such a demonstration, severe enough to produce *a priori* doubts that it could be done; but, as accomplished, revealing new possibilities in the communications art.

GaAs RADIATION—Audio and video signals have been successfully transmitted over a distance of 30 nautical miles with 8400 angstrom radiation emitted by a gallium arsenide diode. Previous papers have described the diode¹ and techniques² with which audio and video signals are transmitted by modulating the diode radiation.

The transmission path between Mt. Wachusett, Princeton, Mass., and the roof of Lincoln Laboratory, Lexington, Mass., a distance of 30 nautical miles, is shown in Fig. 1.

The transmitter situated atop Mt. Wachusett, was basically a small (0.010-inch diameter) GaAs

* Operated with support from the U. S. Army, Navy and Air Force.



Lexington, Mass.—Fig. 1

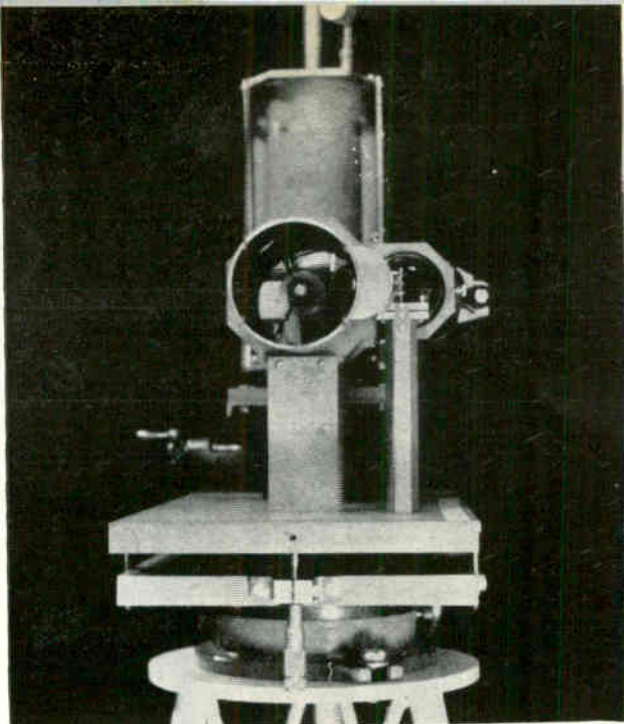
Spans 30 Miles

diode placed at the focal plane of a 5-inch reflecting telescope. This telescope, as shown in Fig. 2, had an effective aperture of $f/1.25$, and confined the diode radiation within a beam of 0.002 radian. The current through the diode, which was immersed in liquid nitrogen, was 300 ma, and the power in the 0.002 radian beam was about 5 milliwatts. The receiver shown in Fig. 3, consisted of a 7102 multiplier phototube placed at the focal point of a 5-foot army surplus searchlight. A filter that rejected all visible radiation, was placed over the face of the multiplier phototube to reduce the noise signals produced by stray radiation from the laboratory and nearby airfield lights. Originally, a spike-reflection filter that was designed to transmit only the 8400 Å diode radiation was used. Because of the short focal length of the searchlight, much of the infrared radiation converged on the multiplier phototube at large angles. Hence, this filter rejected a significant amount of the signal and had to be abandoned.

The communication experiment was performed at night at a time when the atmospheric attenuation of the radiation over the path was about 5 db. Voice and audio communication was of very high quality and the signals received were two orders of magnitude above the system noise.

Television pictures were also transmitted and received. Under best operating conditions, the peak-to-peak television signals were approximately a factor of 20 greater than the system noise. If a properly designed spike filter had been used, the signal-to-noise ratios would have been increased by a factor of 3.

SUMMARY — Although this experiment clearly showed the ability of the GaAs diode to function as a high data rate, long-distance communication device, weather conditions were very good during the experiment, and atmospheric attenuation was relatively low. The system performance will be markedly influenced, however, by the visibility during the time of trans-



REFLECTING telescope in the transmitter has an effective aperture of $f/1.25$ and a field-finder monocular for coincidence viewing of the target—Fig. 2

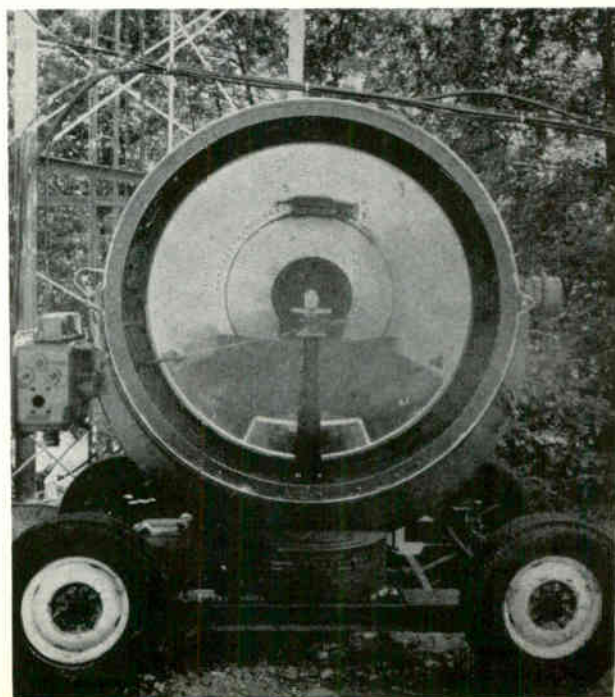
mission. Signal attenuation in the atmosphere is due mainly to the scattering of radiation by moisture and foreign matter. The major source of noise at the receiver is the background photon noise produced by terrestrial lights and the sun.

The authors wish to thank D. S. Grey for designing the transmitter telescope, J. F. Hutzenlaub, W. C. Erwin and D. G. Stuart for supervising the construction of the necessary optics, and J. M. McPhie for technical assistance.

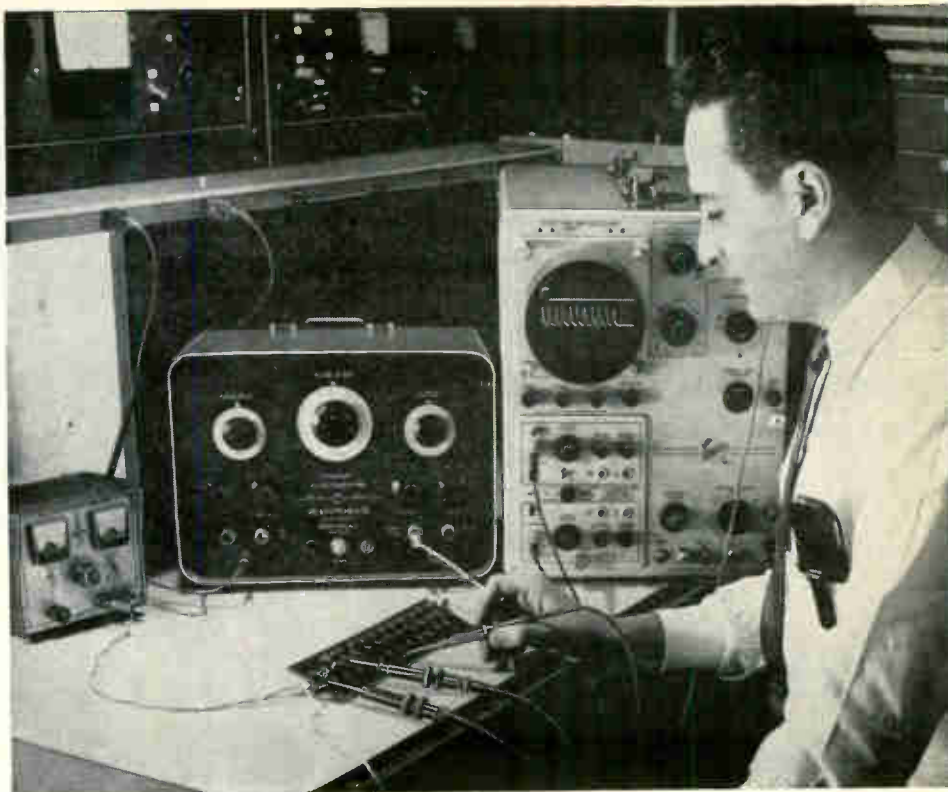
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FIVE-FOOT searchlight with multiplier phototube at focus was used in the receiver for these tests—Fig. 3



TWELVE transistors costing less than 50 cents apiece deliver 11 output pulses for each trigger-input. Author checks out his circuit on double-beam oscilloscope



BASIC one-shot (opposite page) with timing network isolated by dotted lines (A), foundation of pulse-forming chain repeats just the timing stages, not the whole one-shots (B), typical one-shot chain has provision for parallel outputs plus diode gates for serial output (C), waveforms show 11 pulses delivered from each input trigger (D)

Simple Counter Tester

Inexpensive technique generates bursts of 2-Kc pulses at a low repetition rate, permits visual inspection of fast-driven digital counters

By **JOE GAON**, Chief Project Engineer,
Standard Instrument Corp., New York, N. Y.

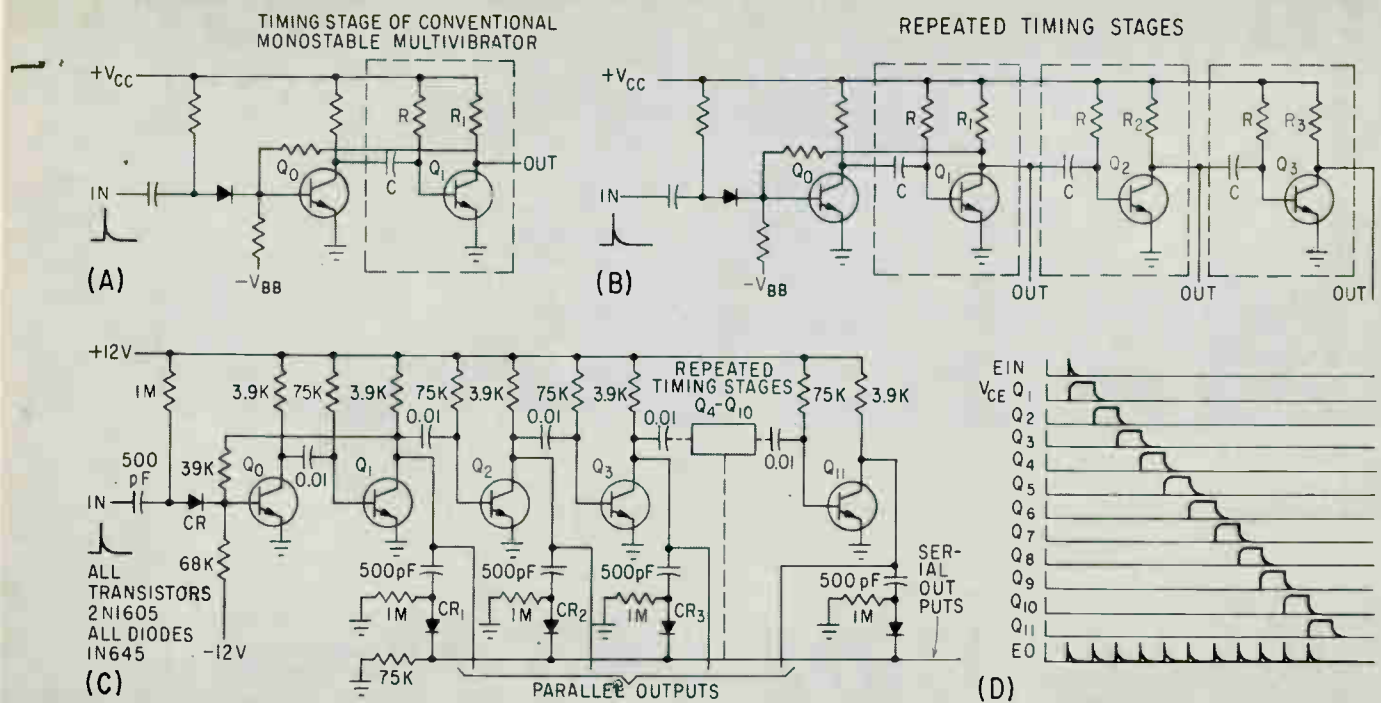
ULTIMATE SIMPLICITY

How would you generate pulses at a 2-Kc repetition rate, yet have these pulses come in bursts of 11 pulses once every 1/10 second? Perhaps the first approach would be an elaborate array of logic modules to gate the 11 pulses from a 2-Kc oscillator to the point where they were required!

Joe Gaon of Standard Instrument Corp. is more subtle. He gets his 11 pulses with the minimum of sweat and runs up a bill for material of less than a dollar per pulse. As you can see, the circuit could scarcely be simpler, yet it would be hard to find a more effective source of counter-testing pulses

THE USEFULNESS of a conventional monostable multivibrator, or one-shot, can be extended by adding redundant stages identical to the timing portion of the basic circuit shown in Fig. A. Figure B illustrates the addition of two identical timing stages to the basic one-shot circuit.

The operation is as follows: during the quasistable state of the basic one-shot chain, transistors, Q_1 , Q_2 , and Q_3 are on an Q_1 is off. Since the collector of Q_1 is at $+V_{cc}$ potential, capacitor C_1 is charged to the same potential through R_1 and the forward biased base-emitter junction of Q_2 . When the one-shot reverts to its stable state, Q_1 is turned on abruptly, causing its collector-emitter potential to drop to a few tenths of a volt; at that instant the base of Q_2 becomes reverse biased by a voltage of magnitude $-V_{ce}$, turning off Q_2 . Transistor Q_3 remains turned off until its base be-



Uses Cascaded One-Shots

comes forward biased, at which time the potential at the collector of Q_0 drops, causing Q_0 to go off in the same way that Q_1 turned Q_0 off.

In this way it is possible to add as many stages as required; the resulting circuit is analogous to a digital delay line.

The timing period of each stage may be calculated from the relation $T = 0.69RC$, where R is in ohms and C is in farads. The total delay is then $T = n(0.69RC)$ where n is the number of timing stages, assuming that all the stages have the same time constant.

Of the many possible applications, two configurations: the sequential pulse distributor and pulse train generator, are described.

SEQUENTIAL PULSE DISTRIBUTOR — In parallel-entry-serial-output counters, it is necessary to sequentially interrogate the memory circuits, a function usually per-

formed by a ring counter. This operation can be greatly simplified by a one-shot chain. The circuit and the resulting input and output wave shapes are shown in Figs. (C) and (D).

When a pulse or positive step is applied to Q_0 , the following timing stages will be turned off and on sequentially, the swing at the collector of each stage interrogating the memory circuits in turn.

PULSE TRAIN GENERATOR — When the outputs of the collectors of all the timing stages of a mono-multi chain are connected to an a-c coupled OR gate, leading to the serial-output terminal in Fig. C, a pulse train generator is realized. The output is a number of pulses equal to the number of timing stages. The circuit is used to test individual decades of electronic decimal counters. A burst of eleven pulses is generated at a rate of ten

bursts per second, the frequency of the pulses is 2Kc.

Whenever a burst of pulses appears at the input terminals of the counter under test, the counter advances by eleven counts in a span of 5.5 milliseconds (eleven pulses 0.5 milliseconds apart) and then rests for 94.5 milliseconds until the next burst arrives.

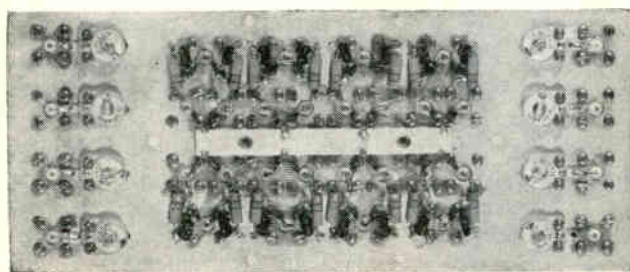
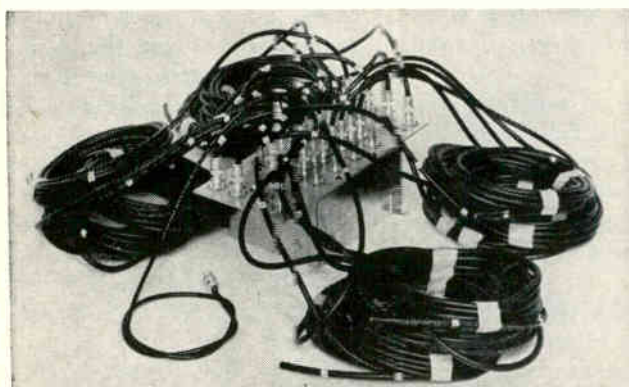
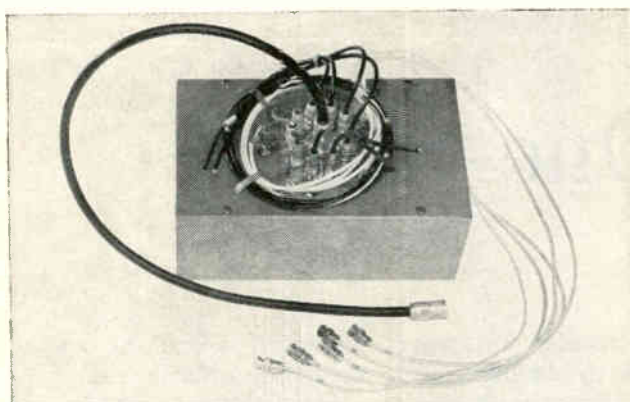
This testing technique enables the inspector to visually examine the performance of a counter while it is being tested at relatively high counting rates.

At the end of each burst of 11 pulses at the 2Kc rate, the units decade (the decade under test) of the counter will advance one digit. For the duration of each burst, the inspector will see a blur, but at the end of the burst the readout will persist long enough (94.5 msec.) for him to detect this one-digit advance indicating a properly functioning instrument.



AUTHORS Morrison (left) and Sarachan test the *i-f* BESS breadboard model, in an arrangement that provides high resolution with an operating bandwidth of 1.25 Mc at 60-Mc center frequency. The eight pairs of coils are of slightly different lengths to provide staggered crossovers at 156-Kc intervals

BINARY FREQUENCY SENSING



*Cyclic impedance variations
output indication of the input*

THE BESS CONCEPT (see box) makes use of the cyclic impedance variations of long transmission lines, terminated in open circuits or short circuits, to generate a binary code output indication of the signal frequency. Several frequency-sensing circuits are used, and each generates one digit in a binary number corresponding to the signal frequency. If five sensing circuits are used to cover an octave in frequency, there are 32 (2 to the 5th power) discrete frequency indications possible. Increased resolution is readily obtained by using additional sensing circuits, as the number of discrete frequency indications is doubled as each sensing circuit is added.

The output indication from the frequency sensing circuits is positive or negative pulses. Diode logic circuits convert the binary coded

ENGINEERING MODEL of *r-f* discriminator for 1.0 to 2.0-Gc frequency meter (top); *r-f* discriminator for *i-f* digital frequency meter, with 10-Mc bandwidth (center); detector circuit for *i-f* frequency meter (bottom)—Fig. 1

FREQUENCY MEASUREMENT WITH BESS

Many techniques have been used for the detection and identification of radio frequency signals. If the signal is of low amplitude and unknown frequency, the receiver must combine high sensitivity and broad bandwidth. If the signal consists of short pulses with a random repetition rate, the receiver must have broad instantaneous bandwidth if a high probability of intercept is to be obtained. The binary electromagnetic signal signature (Bess) concept is capable of detecting and determining the frequency of a single radio frequency pulse at any frequency within the range of the system. Receivers using coaxial components can be designed to cover the entire range of 100 Mc to 4,000 Mc in a single unit, while waveguide versions are expected to operate over an entire waveguide band. All signals in a multiple signal environment can be identified and displayed simultaneously

By R. F. MORRISON, Jr., and M. N. SARACHAN
General Dynamics/Electronics, Rochester, New York

MEASURES A SINGLE PULSE

of long transmission lines, terminated in open or short circuits, generate a binary-coded frequency. Meters operating at 1 to 2 Gc and 55 to 65 Mc are described

information from the frequency sensing circuits to the desired frequency indication.

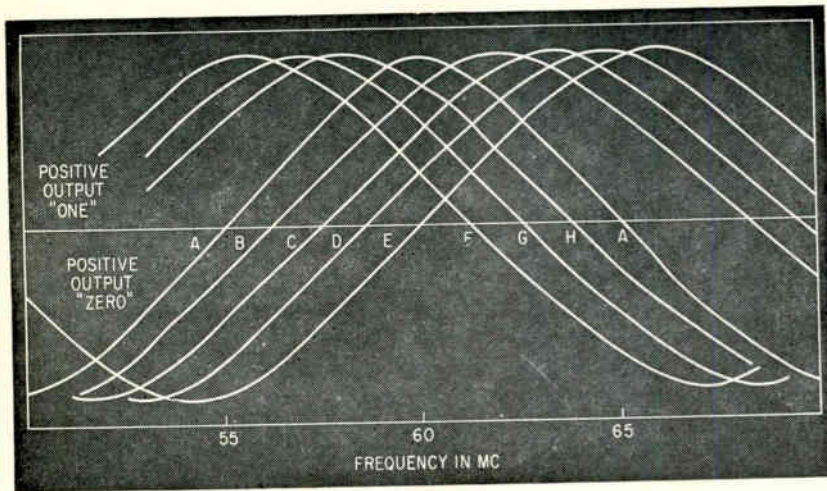
FREQUENCY SENSING— The frequency-sensing circuits are discriminators that are cyclic in nature. The basic discriminator circuit consists of two transmission lines coupled to the input terminal by equal resistors whose resistance is greater than the characteristic impedance of the transmission lines. The transmission lines are equal in length; one is terminated in an open circuit, the other in a short circuit. If the input voltage is maintained constant and the frequency is varied, the voltage at the junction of the open-circuited transmission line and the coupling resistor will pass through minimum values when the length of the line is equal to an odd number of quarter wavelengths, while the voltage at the junction of the short-circuited transmission line and the coupling resistor will pass through minimum values when the length of the line is equal to an even number of quarter wavelengths. The

voltages at the two junctions will be equal whenever the line lengths are equal to an odd number of eighth wavelengths. Diode detectors convert the r-f voltage at the junctions to video pulses. One of the diodes produces positive pulses, the other produces negative pulses. An indication of the relationship between the transmission line length and the input wavelength is obtained by adding the video pulses and observing the polarity. The frequency interval between polarity reversals is inversely proportional to the length of the transmission lines. An unambiguous indication of the input frequency can be obtained by using several pairs of lines of different lengths, so that each pair of lines contributes one digit to a binary indication of the input frequency.

This discriminator circuit operates satisfactorily over a wide dynamic range because the amplitude of the combined video output pulse is not significant. Variation in the responses of the two detectors will cause some variation in the frequency at which polarity reversal

takes place, but this variation is minimized by choosing diodes with similar characteristics. The non-linear response of the detectors is not significant as long as both diodes exhibit the same characteristics. The effect of differences between detectors is further minimized by the fact that the voltage applied to both diodes varies rapidly with frequency in the vicinity of the frequency at which polarity reversal takes place.

A different type of discriminator circuit has been used with waveguide components. The discriminator is made up of two hybrid tee junctions, two transmission lines of unequal length and a balanced detector. The signal enters the discriminator through the H-plane arm of one hybrid tee and proceeds through the unequal paths to the second hybrid tee, which it enters through the two collinear arms. The signal will emerge at the E and H arms of the tee junction, and the ratio of the signal amplitudes at these arms is determined by the frequency of the input signal and the difference in the lengths of the



DETECTOR OUTPUT POLARITY versus frequency, for *i-f* frequency meter with 10-Mc bandwidth—Fig. 2

two paths connecting the hybrid tees. The amplitudes will be equal at all frequencies that result in a differential phase shift of 90 degrees for the two paths. Diode detectors connected to the E-plane and H-plane arms of the tee junction produce negative and positive video pulses, respectively, and the video voltages are added so that a null results when the amplitudes are equal. Polarity reversals take place each time the frequency changes by an amount sufficient to change the differential path length by one-half wavelength. Several waveguide discriminators of different lengths are used to produce a binary code indicative of the signal frequency.

BESS RECEIVER—One Bess receiver was designed to operate in the 1.0 to 2.0-Gc frequency range. The coaxial lines used as discriminators are shown in Fig. 1 (top). The equivalent free space length of the shortest pair of lines is three inches; the equivalent length of the longest pair is 48 inches. The shortest pair produces polarity reversals or crossovers at 1,000-Mc intervals with the first reversal at 500 Mc; the next pair produces reversals at 500-Mc intervals starting at 250 Mc; and the longest pair produces reversals at 62.5-Mc intervals starting at 31.25 Mc. The reversals of the five lines overlap to form a Gray code dividing the 1.0 to 2.0-Gc region into 32 slots of 31.25 Mc each.

The five-pair discriminator produces erroneous frequency indica-

tions if frequencies below 1.0 Gc or above 2.0 Gc are introduced. These erroneous responses can be eliminated by the use of two additional pairs of transmission lines of proper lengths to produce first reversals at 1.0 Gc and 2.0 Gc. The frequency sensitivity of these lines is much less than that of the longer lines so the location of the band edges will not be accurate unless additional longer lines of appropriate length are used to improve the resolution in the vicinity of the band edges.

The digital circuits consist of a solid-state pulse shaper for each diode detector, decode logic and display unit.

Each pulse shaper consists of a nonlinear amplifier with a voltage gain of 60 db, an input signal dynamic range of 20 db, and capable of responding to pulse widths ranging from 100 nsec to several msec. The amplifiers will respond to positive polarity input pulses only, and are followed by pulse shapers that produce shaped pulses of one microsecond duration at an amplitude compatible with the requirements of the logic modules. The shaper output is fed into the decode logic.

Conventional multilevel diode gating, as dictated by the optimum solution of the Boolean equations, is used for decoding the five-bit Gray code detector outputs into 32 discrete frequency slots. Ambiguities, which inherently occur at the crossover frequencies, are resolved by defining these points as binary zeros. This is accomplished by

TABLE—DIGITAL OUTPUT CODE

Frequency in Mc	A	B	C	D	E	F	G	H
45.00 to 55.00	0	-	-	-	-	-	-	-
55.00 to 56.25	1	0	0	0	0	1	1	1
56.26 to 57.50	1	1	0	0	0	1	1	1
57.51 to 58.75	1	1	1	0	0	1	1	1
58.76 to 60.00	1	1	1	1	0	1	1	1
60.01 to 61.25	1	1	1	1	1	1	1	1
61.26 to 62.50	1	1	1	1	1	0	1	1
62.51 to 63.75	1	1	1	1	1	0	0	1
63.76 to 65.00	1	1	1	1	1	0	0	0
65.00 to 75.00	0	-	-	-	-	-	-	-

strobing the output of each pulse shaper. The presence of a shaper output, or ONE bit, will inhibit the strobe from the ZERO line. At any shaper output for which the ONE pulse is not present (regardless of whether the outputs of the associated line pairs are in the negative or null configuration), the strobe pulse will be enabled. As a result, whenever an input signal is present, a pulse will be present on either the ONE or the ZERO line corresponding to each of the five detector outputs.

The strobe pulse is produced by ORing the outputs of the shapers associated with the two shortest line pairs along with the ZERO output of the shortest line pair. The shortest line pair is the only one for which the negative or ZERO detector output is amplified.

Pulse stretchers are provided at each of the 32 decoded output lines to provide a 400- μ sec pulse, which is sufficient duration to illuminate the display. This technique enables the frequency measurement of two pulses whose leading edges are approximately 2 μ sec apart. If this resolution is not required, the output pulse stretchers can be eliminated and the amplifier pulse shapers modified to produce the 400- μ sec pulses.

The display currently in use consists of an in-line array of neon indicator tubes. A diode-capacitor storage circuit maintains reasonable persistence of the neon bulb. A multivibrator storage circuit could be substituted to hold the indicator on until reset. Each tube

represents one decoded frequency slot, offering the advantages of similarity to the familiar panoramic type of frequency display and the capability of indicating several frequencies simultaneously.

The Gray-code frequency information can also be encoded into any desired form (binary, binary coded decimal or decimal) by similar techniques. Information storage by core matrix, disk, tape, or delay line can readily be incorporated. Digital displays of the Nixie or electro-luminescent type or analog displays (oscilloscope) can be substituted for the in-line readout.

I-F BESS UNIT—The Bess unit shown in Fig. 1 (center and bottom) is designed for operation in the vicinity of 60 Mc. This version of the device is intended for high-resolution frequency measurement of pulsed signals after conversion to an intermediate frequency in the vicinity of 60 Mc. The Bess unit shown uses eight pairs of transmission lines to divide a band into eight equal segments. The device as shown operates over a 10-Mc band centered at 60 Mc. The longest pair of transmission lines has an equivalent free-space length of 750 cm, and it produces polarity reversals at 10-Mc intervals starting at 5 Mc. The other seven pairs are shorter than the first pair. Each pair produces one reversal between 55 Mc and 65 Mc, so that the eight pairs produce nine reversals, dividing the band into 1.25-Mc intervals. The manner in which the 10-Mc band is divided and the resulting digital code is shown in Fig. 2 and the table.

A schematic diagram of the i-f Bess unit is shown in Fig. 3. The 2.2- μ h chokes maintain balanced d-c conditions for the two detectors, while the 1,000-ohm resistors in series with the diodes help to stabilize balance conditions by equalizing the series resistances in the detector circuits. The open-circuited lines are terminated in variable capacitors which are used for fine adjustment of the crossover frequency.

For the i-f Bess units, the same pulse-shaper and display techniques are used, the only area of difference being in the decode logic. In this

case, one pair of coax lines defines the actual i-f band being measured; that is, if the bandwidth of interest is 10 Mc, the crossover points of this line would be 10 Mc apart and equidistant from the mean i-f frequency. The amplified and shaped output of this line is used as the strobe for producing the binary ZEROS for the remaining seven detector outputs. Otherwise the technique for avoiding ambiguity is identical to that used in the 1.0 to 2.0-Gc unit.

Since each of seven of the coax line pairs has only one crossover point within the frequency range of interest, the code produced does not follow any standard pattern. The information, however, can still be decoded into the eight slots required for the in-line array type of display, or converted into any standard code using standard logic techniques.

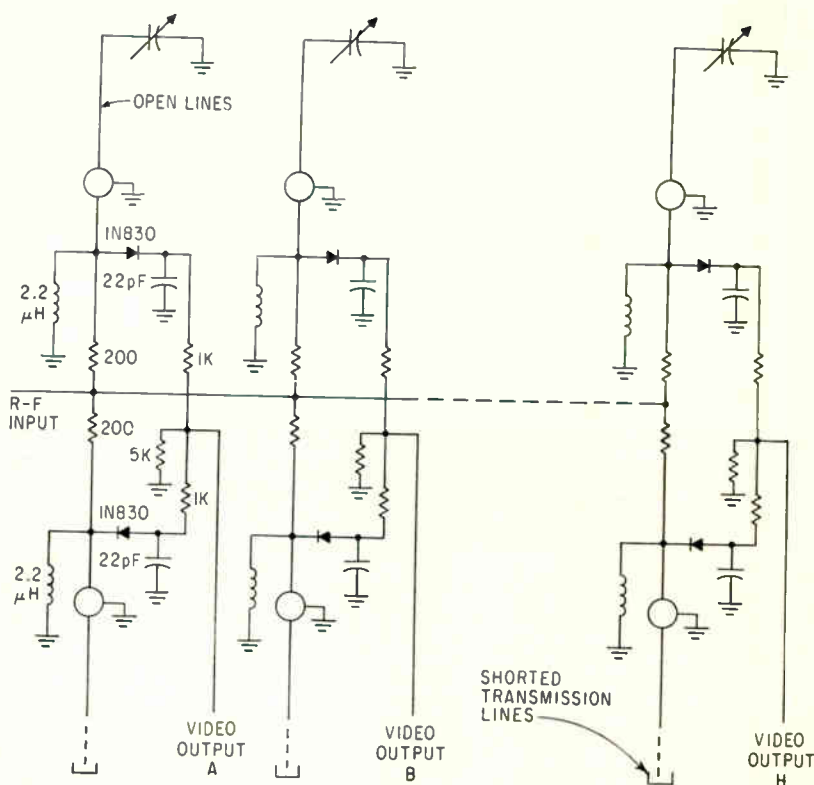
LIMITATIONS—In theory, it appears that the resolution of the Bess concept can be increased without limit by using extremely long transmission lines. In practice, the length of the transmission lines is limited by line attenuation and the

requirement that the pulse duration must exceed the two-way propagation time along the transmission line. Satisfactory operation has been obtained with a pulse duration equal to twice the two-way propagation time. If it is assumed that the propagation time should not exceed twice the pulse duration, the maximum line length for 0.25- μ sec pulses is about 60 feet and the corresponding frequency interval between polarity reversals is 4.0 Mc.

The maximum line length is also limited by the attenuation of the transmission lines. This is particularly true of the small diameter coaxial lines which can be packaged in a small volume.

The magnitude of the signal reflected from the end of the transmission line will be small if the line has high attenuation and the variation of the detector voltages with frequency will be correspondingly small. If the two-way line attenuation is 6 db, the reflected voltage magnitude is half the incident voltage and the variation of detector voltage with line length is 3 to 1, which is adequate for good frequency resolution.

The maximum usable line length



I-F DIGITAL frequency meter—Fig. 3

based on a maximum attenuation of 6 db varies as a function of frequency and is directly related to cable size. At a frequency of 3 Gc, the maximum usable length of RG-62A/U cable is about 16 feet, which provides a frequency resolution of 12 Mc between polarity reversals. The attenuation of this cable decreases with frequency, so that at a frequency of 100 Mc, the maximum usable length is over 100 feet with polarity reversals of less than 2 Mc.

SIGNAL LEVEL—The relationship between frequency and detector output voltage is shown for several signal levels in Fig. 4A. The frequency at which a null occurs in the output voltage does not change significantly with signal level, but the slope of the detector

response will cause an apparent shift of the null frequency with signal level if a specific threshold detection level such as 2 mv is assumed.

The accuracy of frequency measurement is not appreciably changed by amplitude effects, because the shift in the apparent location of the null is small compared to the separation of the nulls.

The signal power level required to produce a usable output pulse is about -10 dbm. This is much greater than the available signal power in many applications and amplification will be required. The sensitivity that can be achieved is related to the amplifier noise figure and bandwidth.

Wideband noise does not change the d-c level at the output of the balanced detectors, but it does gen-

erate a background video level that the signal must exceed to be recognized. The video pulse voltage resulting from the detection of an input signal is a function of the signal frequency and signal power level.

The signal-to-noise ratio required is determined by the frequency accuracy requirements and the permissible false indication rate. Infrequent noise pulses that exceed the average noise level by a large amount will cause false indication if the threshold level is set too close to noise level. Setting the threshold detection level too high decreases the frequency accuracy, by shifting the apparent null locations for weak signals.

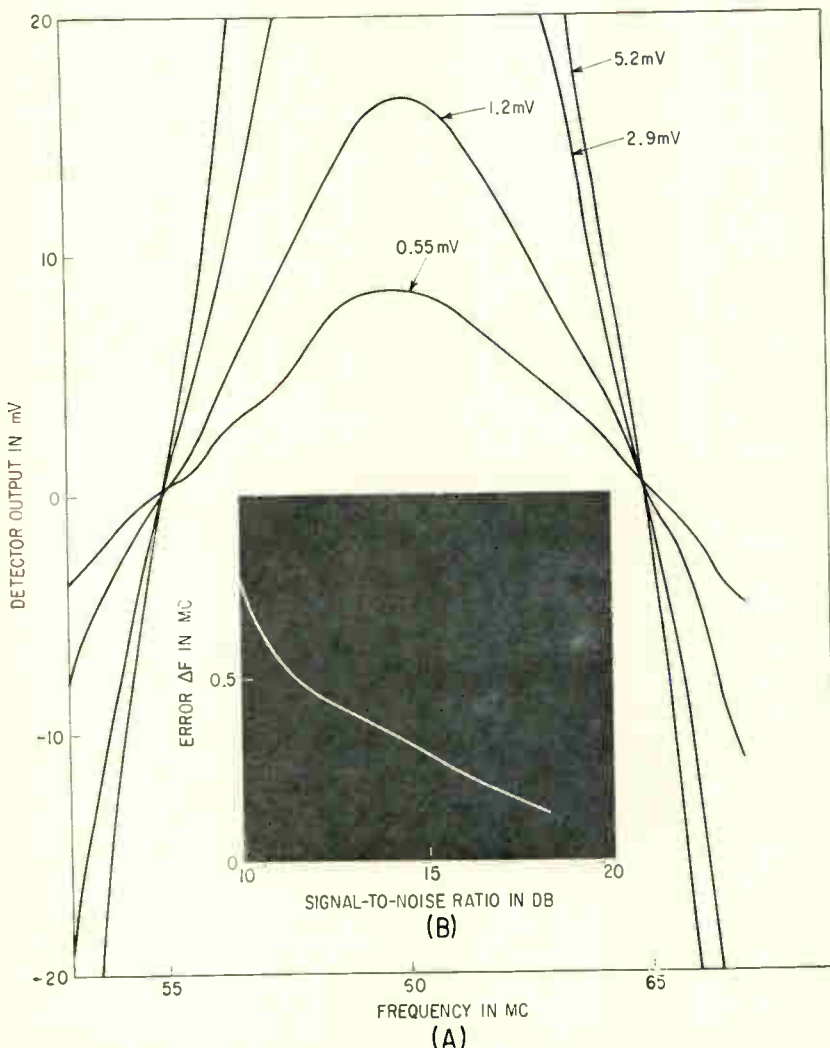
The relationship between signal-to-noise ratio and measurement accuracy was investigated by using a tee junction to connect a broadband noise source and a pulsed signal generator to the input of the i-f Bess unit.

The results shown in Fig. 4B are for a pair of transmission lines that produced polarity reversals at 10-Mc intervals. The curve plotted shows the combination of signal-to-noise ratio and frequency deviation from the null frequency required to produce a signal video pulse amplitude equal to twice the apparent maximum noise amplitude.

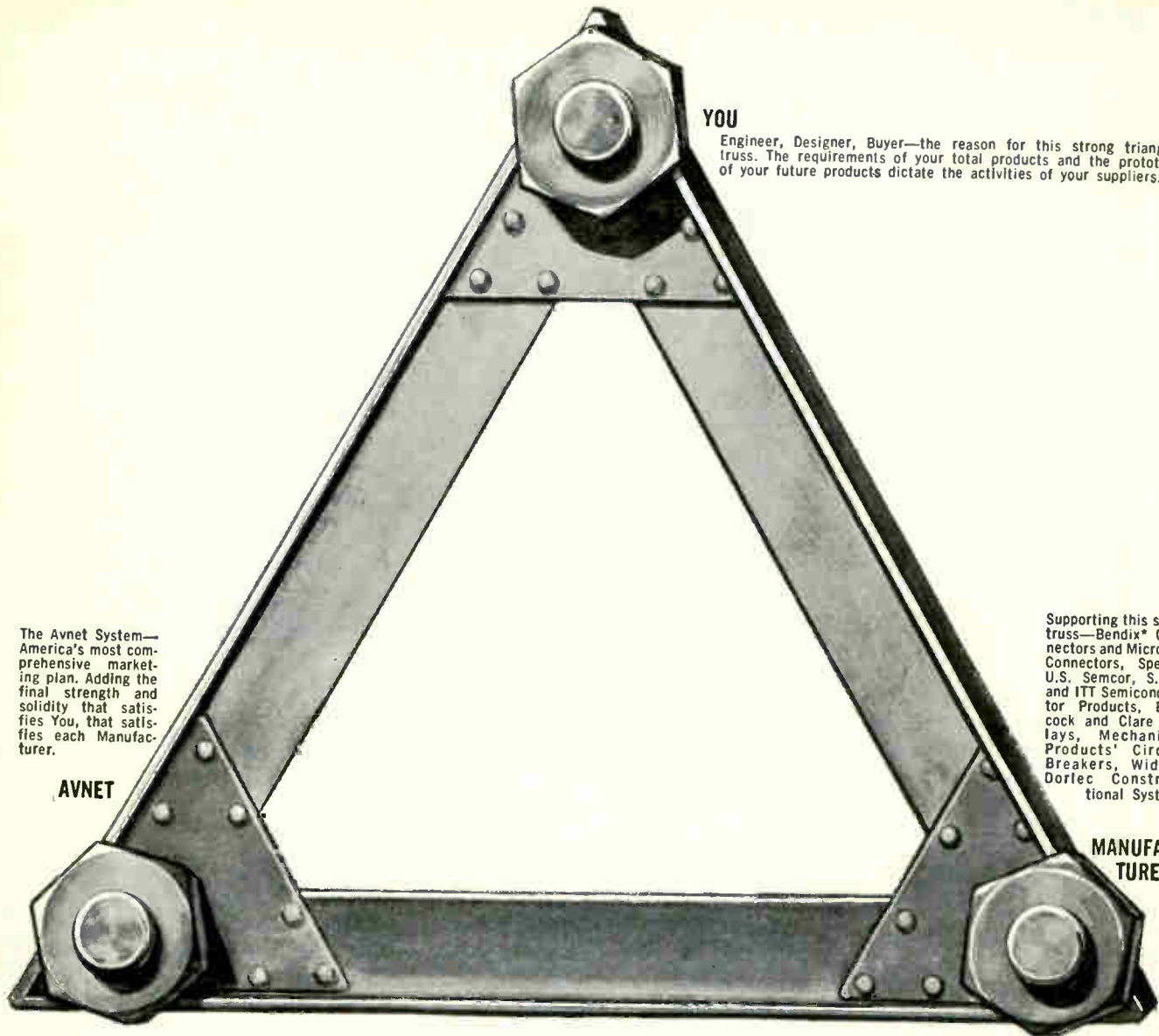
A signal-to-noise ratio of 15 db is sufficient to provide a null location accuracy of about 3 percent of the frequency interval between polarity reversals.

The minimum detectable signal level is determined by the receiver bandwidth, the amplifier noise figure and the signal-to-noise ratio. An i-f Bess unit with an amplifier bandwidth of 20 Mc and a noise figure of 5 db would be capable of detecting signals at a level of -80 dbm with good accuracy, and -85 dbm signals with decreased accuracy. Similar considerations result in an estimated sensitivity of -60 dbm for an S-band Bess receiver with a low-noise traveling wave r-f amplifier and a bandwidth of 2,000 Mc.

The authors acknowledge the assistance of N. Y. Woo in conducting the major portion of the experimental work on this project.



VOLTAGE versus frequency at video output A of Fig. 3 (A); input signal-to-noise ratio versus frequency deviation from null to produce video signal-to-noise ratio of 6 db (B)—Fig. 4



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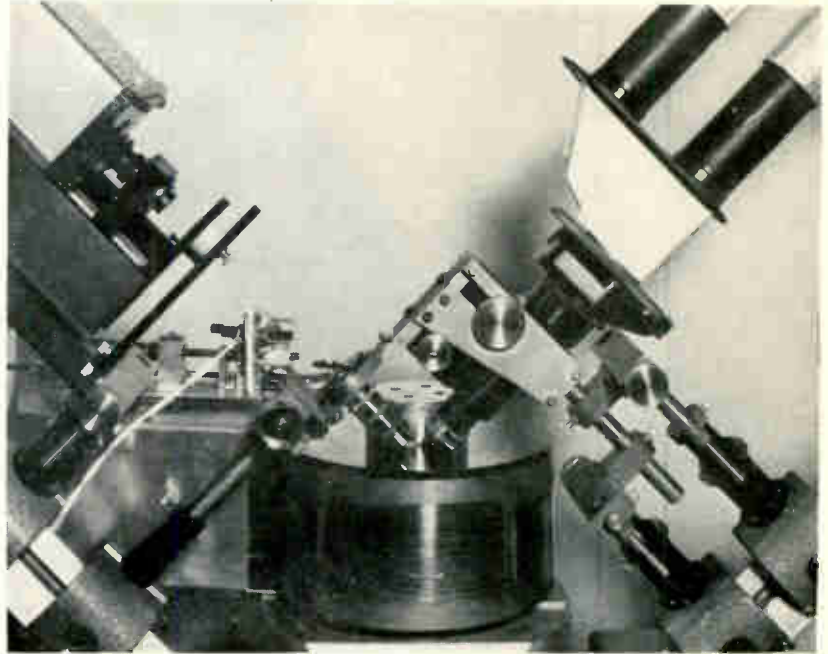


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MAGNETIC DISK, center, is on variable precision spindle. Variable inclination optical benches, right and left, carry He-Ne gas laser, left, and multiplier phototubes, right, that read out information through a microscope. At rear left is a movable magnetic head mechanism for recording



Kerr-Effect Readout Uses Gas Laser

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MAGNETIC DISK READOUT by the Kerr magneto-optical effect, using a neon-helium gas continuous laser for a light source, has been achieved by IBM's General Products Development Labs in

San Jose, Calif. IBM scientists Bruce Edwards and Otto Kornei told **ELECTRONICS** that the continuous gas laser offers a substantial improvement in resolution and in readout signal-to-noise ratio over conventional light sources, that have been used with the Kerr effect in the past.

The experimental system, shown on the cover and in the figure, uses a Perkin-Elmer Spectra-Physics gas laser, giving a 10-milliwatt

output at 6,328 Å, aimed through a condenser lens at an 8-inch disk with a magnetic coating of high coercivity. PhotoMultiplier phototube used for the readout has a low-noise, high-sensitivity and high quantum efficiency photocathode at the laser wavelength. A gliding magnetic head access mechanism is provided for experimental writing.

Because of its spatial coherence and the resulting high power density, the laser beam can be focused on a spot limited in size only by optical resolution; this enables readout of magnetic spots 5 microns in diameter. Since the readout signal-to-noise ratio varies as the square root of the power density, the ratio is improved by a factor of about 30 over conventional light sources.

Readout has been carried out at 250 kilocycles. Since the lineal information density is being resolved by an approximately circular focused spot, it will be possible to read out information with an area density of at least 250,000 bits per square inch. Presently

THE KERR EFFECTS

Kerr magneto-optical effect, used in this story, should not be confused with the Kerr electro-optical effect, also much in the news these days. They're two different things.

If plane-polarized light is reflected from the polished pole of a strong magnet, the light becomes slightly elliptically polarized; this can be measured as a rotation of the plane of vibration through an angle proportional to the magnetizing force. This is Kerr magneto-optical effect. The polarized light is here provided by the Brewster-angle quartz windows of the gas laser.

Kerr electro-optical effect says that an isotropic substance, such as nitrobenzene, becomes anisotropic in presence of an electric field—this is used in Kerr cells, for modulating laser light beams

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ABC 7.5-2M	0-7.5	0-2	0.5	0.002	0.01	0.05+0.5	\$159
ABC 15-1M	0-15	0-1	0.5	0.008	0.01	0.02+0.2	\$159
ABC 30-0.3M	0-30	0-0.3	0.3	0.05	0.02	0.1 +1	\$179
ABC 40-0.5M	0-40	0-0.5	0.5	0.04	0.02	0.04+0.2	\$159

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MODEL	DC OUTPUT RANGE		INPUT AMPS (MAX.)	OUTPUT IMPEDANCE OHMS MAX			PRICE
	VOLTS	MA		DC to 100 CPS	100 CPS to 1 KC	1 KC-100 KC (+ μhy)*	
ABC 200M	0-200	0-100	0.5	1	0.5	2+1	\$199
ABC 425M	0-425	0-50	0.5	4	1	2+1	\$199
ABC 1000M	0-1000	0-20	0.5	25	2	2+1	\$274
ABC 1500M	0-1500	0-5	0.3	150	2	2+1	\$274
ABC 2500M	0-2500	0-2	0.3	625	2	2+1	\$334

*Effective series inductance.



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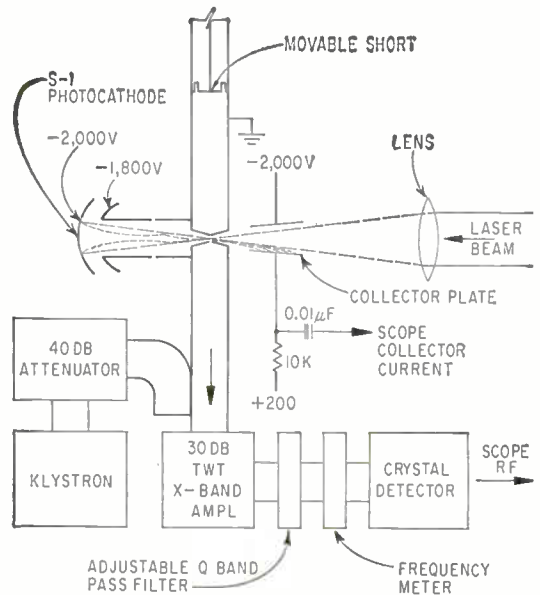
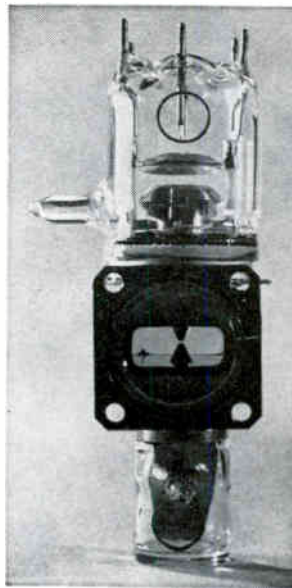
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realizable is the readout of 1,000 bits per inch at speeds of 500 Kc, and a density of 500 bits per

inch has actually been achieved with recording of non-return-to-zero coded information.



MICROWAVE PHOTOTUBE, showing the interaction gap in the center, and photoemissive surface at top, left. Experimental setup illustrates demodulation process, right.

X-Band Microwave Laser Demodulator

MICROWAVE PHOTOTUBE for demodulation of laser light beams has been developed by National Engineering Science Co., Pasadena, Calif. The new detector tube, jointly sponsored by Douglas Aircraft Co., demodulates frequencies of 8 to 12 Gc from a 0.3 to 1.2 micron laser beam.

Microwave power levels down to the order of a nanowatt can be demodulated, with a signal-to-noise ratio of 10 on input light power of 50 microwatts for a-m, and 10 microwatts for f-m signals. The tube has flanges for fitting an X-band waveguide.

The experimental setup shown in the figure uses an S-1 (silver-oxide-cesium oxide) photocathode with a broad-wave microwave interaction structure. The cathode is part of an electron gun that focuses the photocurrent as it passes, in a narrow beam, through an interaction gap set up by two hollow reentrant cones mounted in the walls of an X-band waveguide. The beam tunnel at the interaction gap is 0.045 in. in diameter, and the gap is 0.025 in. wide.

By focusing the light through the interaction gap, the cathode is illuminated over an area about 1.5 cm in diameter.

The tube has been studied by photomixing neighboring axial mode emissions from a ruby laser.

The ruby laser is pumped above threshold, and produces a large number of overlapping coherent pulses a few microseconds in duration. Each pulse is the result of a given axial or near-axial mode of the resonator being driven by stimulated emission; the optical frequencies of the various modes are distributed about the center frequency of the crystal fluorescence and are separated by microwave frequencies that are related to the length and index of refraction of the particular ruby rod.

When the laser beam hits the photocathode, it emits current consisting of two components: a large component that has no microwave modulation, and a small microwave modulated component due to the "square-law" demodulation of beats during overlap of different axial-mode pulses.

New Mallory packaged doubler priced 30% under dual rectifiers



Here's a tremendous breakthrough in silicon rectifiers—the new Mallory Type VBM. It is a packaged voltage doubler circuit priced 30% below the cost of a pair of single rectifiers. And it has superior reliability—for it uses the same rectifier cell, the same encapsulating technique, as Mallory single unit rectifiers that have racked up a field return rate of only 0.019% over the past three years.

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device in assembly costs. And you increase overall reliability.

Current rating of the Type VBM is 350 milliamperes at 85°C. It is available in PRV values from 50 to 600 volts. Forward voltage drop and reverse leakage are exceptionally low—0.5 volt and 0.1 milliamperes respectively, full cycle average at rated current and maximum ambient temperature. This unusual device is also available in center tap configurations, with either positive or negative output.

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Making the Right Connection

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LARGE connector company now plans to go beyond limits of their traditional connector business, and encompass all phases of circuit design and packaging.

Amphenol-Borg plans to develop and produce packaged circuits of all types. Unified systems will include cordwood modules, entire motherboards, thin-film devices, and integrated circuits.

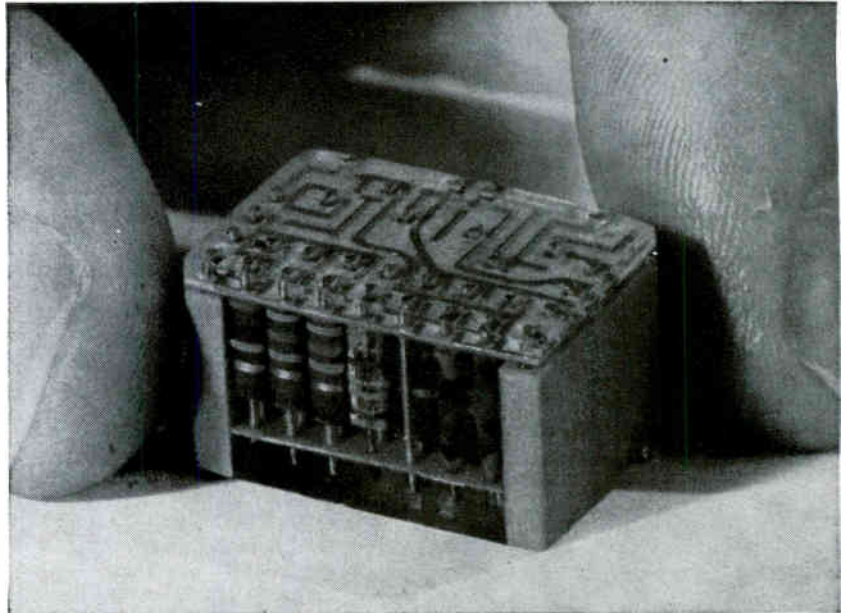
Company's existing products—connectors—will still be emphasized. They remain interconnection specialists. "But today's complex electronics circuits demand consideration of unified interconnection systems rather than the piece-by-piece design approach used up until now", says division president J. Frank Leach.

Decision to encompass systems was prompted, in part, by customer need for technical advice on how to interconnect circuits. This includes questions customers raise on how to make interconnections smaller, more economical and more reliable.

NATURAL GROWTH—Company still believes conventional connectors will handle significant percentage of interconnecting applications in foreseeable future. But natural growth of electronics means continued growth for them, they say. Even though they introduced no radically new products or concepts themselves.

Leslie E. Roby, manager of Interconnections/Systems Packaging group, would not reveal details now, but hints at new techniques for interconnecting thin-film devices and integrated circuits. Announcement of this development is expected within the year.

Richard E. Hall, vice-president



CONNECTORS make up sides of cordwood package and provide plug-in connections to other equipment. Intercon printed circuit boards on top and bottom provide wiring. Amphenol-Borg says this is only one phase of their complete interconnections-systems program

of marketing, says the conventional connector industry sales represents about 1.8 percent of the \$13 billion electronic equipment market. He estimates the potential for interconnected packages runs between 15 and 40 percent of the electronic equipment sales dollar.

Potential for interconnecting subsystems modules on one computer accounts for 33 percent of total cost.

Hall says these figures show company's systems approach will enable them to go after much broader sales market.

Superconductor Faces Neutron Irradiation

SUPERCONDUCTING magnet at Wright-Patterson AFB will be exposed to neutron irradiation to find out what changes might take place in its characteristics, such as critical field and transition temperature. Magnet is now being developed by Magnion, Inc.

Eventually, it will be used for research on plasma and electrical and electromagnetic propulsion systems. It is designed to reach a field of 26,000 gauss. It will be 4 in. length and have a 2-in. ID (1½-inch work-

ing volume at room temperature).

Another Magnion superconductor has been delivered to NASA's Goddard Space Flight Center. Tests will determine the feasibility of using such devices to measure the ion composition in the lower atmosphere. It obtains a maximum field strength of over 26,000 gauss in air at room temperature in a working volume ½-in. in diameter by 8 in. long. The niobium-zirconium solenoid itself has a 2-in. ID.

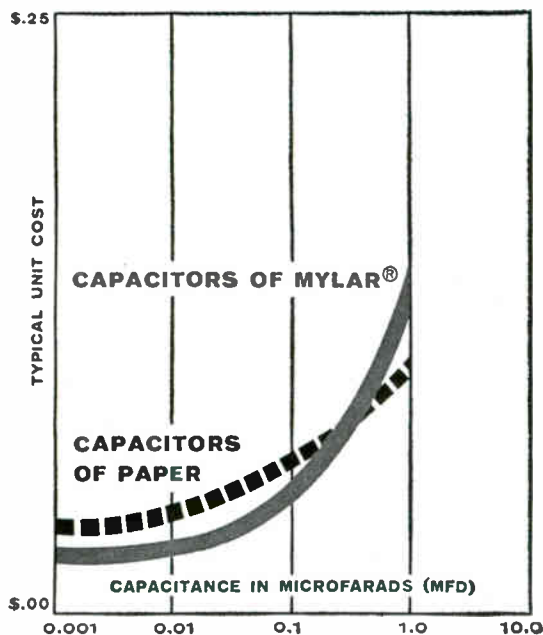
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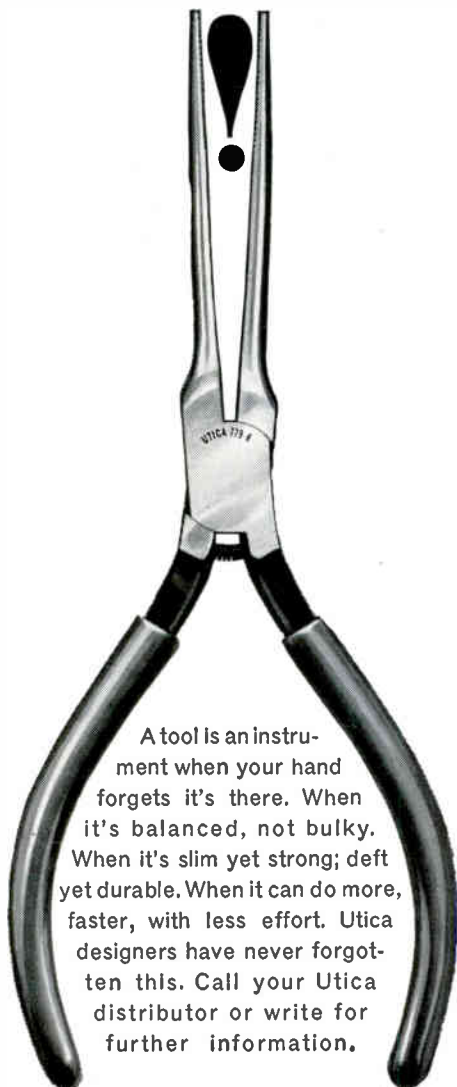




*a pair of pliers is just a pair
of pliers... unless it's*

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is compensated by varying the winding density to increase uniformity of the magnetic field along its axis has been delivered to General Electric to test superconducting materials.

The niobium-zirconium solenoid, also made by Magnion, produces a peak field of 50,000 gauss. It has a ½-in. ID, 4-in. OD, and an active coil length of 3 in. To achieve the same degree of uniformity without compensation, the coil would have to be more than twice as long, company says.

Increased Power For Silicon Planar Devices

TWENTY amp silicon npn power transistor will be introduced by Honeywell Semiconductor Products in a month or so. Component will be a planar, triple-diffused high-frequency high gain unit. Device is a beefed up version of Honeywell's 10 amp unit, shown last week at the IEEE show. Company will aim for big market seen in power devices of this type for d-c amplifiers, d-c a-c inverters, and rf amplifiers.

Foam Sealant Solves Computer Problem

AN AIR-TIGHT permanent seal was required in a computer console to prevent the escape of cooling air from the interface between the cooling fan housing and the console bulkhead. The computer operates in controlled environments to collect and collate essential performance data on inertial guidance systems.

The sealing problem was reportedly solved by a foamed polyurethane plastic whose cell walls are coated with asphalt bitumen. When compressed to fit into joints, resilient Compribrand sealant grips onto joint interfaces and maintains firm adhesion in spite of movement, vibration and temperature changes.

The joint sealant combines a spongy compressible foam with an asphalt adhesive.

Recovery and expansion characteristics of the sealant can be used between any two materials. Ma-

material has been available since 1961 but until recently has been imported from Holland. Sealant is now available from Pacific Sealants, Hawthorne, California.

Bilateral Switch Controls Both Parts of Cycle

LAST WEEK, Transatron announced switching diode that replaces 2 controlled rectifiers. Essentially a two-lead bilateral unit, the Bi-Switch, is mounted in a top-hat rectifier package, modified for heat sinking purposes.

Specific applications are seen for motor controls, light dimmers, temperature controls and transient protection.

Initial types now in production are 200 volts, 5 amp; 200 volt 3 amp; and 200 volt one amp units, specifically designed for a-c phase control applications.

Switching diodes can also be used in transient protective circuits. At a latter date, Transatron expects to market both higher and lower voltage units.

The TBS-20A type is rated for operation up to 150 C and can carry 5 amps rms at 100 C case temperature. Control is achieved both in the negative and positive parts of the cycle due to the bilateral symmetrical nature of the switch. Hence the unit basically replaces two silicon controlled rectifiers.

Winding for 50,000 Gauss



SUPERCONDUCTING magnet being wound at Westinghouse Electric



Photo by Reeves Instrument Corporation
Garden City, New York

Inland Gearless Torquers give 2-axis precision to Reeves Radar Pedestals

Precision Radar Pedestals . . . manufactured by Reeves Instrument Corporation, Subsidiary of Dynamics Corporation of America . . . play vital roles in major satellite and missile programs. Designed to accommodate reflectors up to 30-feet in diameter, they feature 5-second angular accuracy, azimuth load bearing ratings at 250,000 pounds and tracking rates from zero to 10 rpm in azimuth and from zero to 1/2 radian/second in elevation.

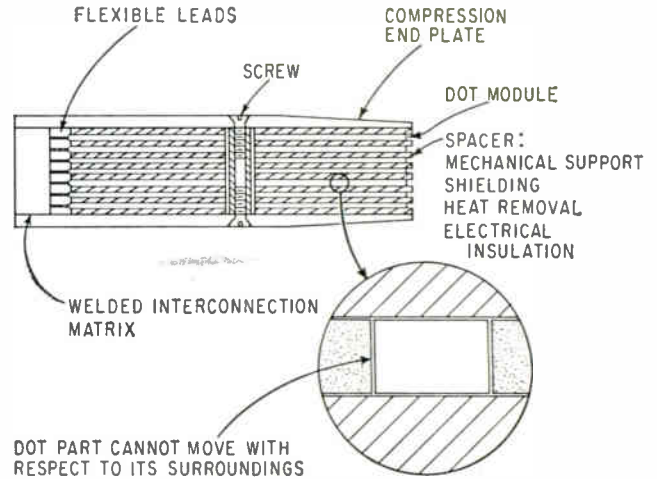
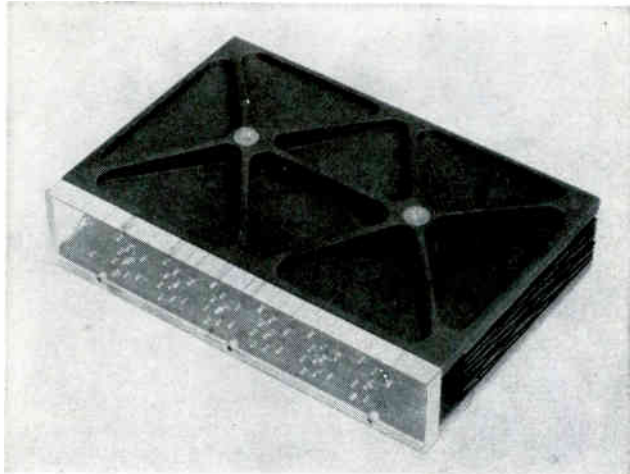
Accurate 2-axis servo-positioning of these Reeves Pedestals is effected by Inland Gearless Torquers ranging in torque output from 500 to 3,000 pound-feet.

Fast, high-resolution response to servo-position error signals is a major reason why Inland Gearless Torquers win so many missile and space-vehicle assignments. The superior performance of these direct-drive d-c torque motors comes from torque-to-inertia ratios 10 times higher than equivalent gear-train servo motors. Moreover, their compact pancake configuration meets space and weight restrictions.

What's your problem? If you're currently planning a servo system calling for output torque between 20 ounce-inches and 3000 pound-feet*, compare Inland Gearless Torquers with any alternative. Write for all the facts today, 347 King Street, Northampton, Massachusetts.

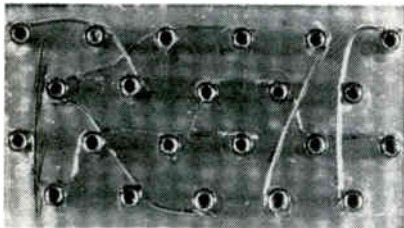
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SYSTEM ASSEMBLY has welded tube matrix that acts as "book binder" and holds leads connecting thin card-shaped dot-or-pellet modules. End-plates and foil-clad balsa wood spacers provide a prestressed system structure—Fig. 1

System Packaging Uses Book Configuration



HOLLOW TUBES welded together receive module interconnecting leads that are soldered inside tubes at end of assembly procedure—Fig. 2

Seven thin modules hold 1,200 parts, package highly resistant to shock

By J. R. GOODYKOONTZ
Space Technology Laboratories, Inc.
Redondo Beach, California

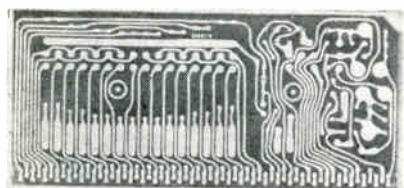
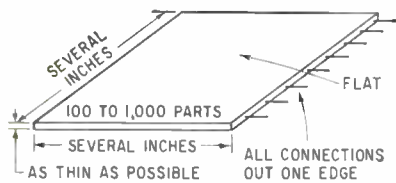
DIGITAL telemetry unit now being built exemplifies the system packaging uniformity attained with card-shaped dot-or-pellet modules. Previously the unit was packaged using welded cordwood modules. The new packaging concept provides advantages with respect to: reliability, fabrication ease, repairability, etc. in this particular application.

OVERALL UNIT—The unit (Fig. 1) consists of some 1,200 parts disposed on the 7 card-shaped modules that measure 3 inches by 6.7 inches by 0.03 inch. Made of molded epoxy, the modules are color-coded for assembly as well as for trouble shooting purposes. Intraconnections within individual modules are made with silk-screened conductive adhesive. Interconnections between

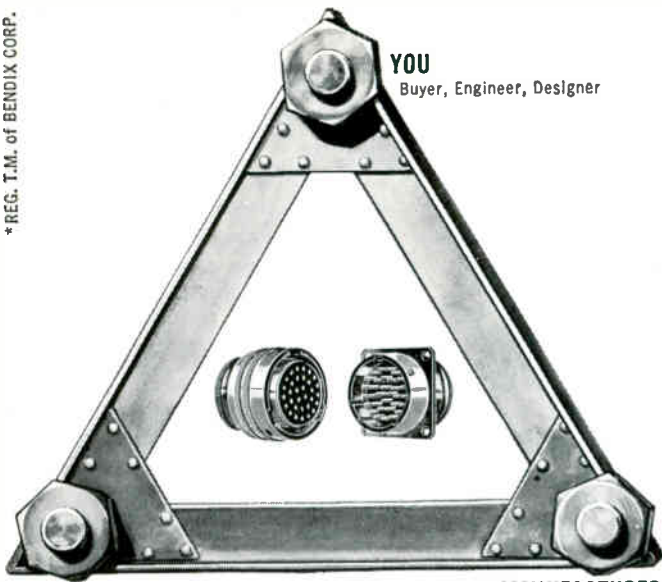
modules are brought-out along one edge of each module in the form of flexible, multistranded wires. An interconnection matrix with a horizontal-welded-tube configuration accepts those wires which are solder-connected inside tubes. Acting as a "book binder," the tube matrix provides a "book" configuration for the system package. By treating the modules as pages in a book, all parts are accessible for inspection or replacement without disconnecting any part of the system. Modules are held separate by means of foil-clad balsa wood spacers. These, together with rigid end-plates containing screws, provide a compact, prestressed structure highly resistant to shock and vibration.

INTERCONNECTION MATRIX—Hollow tubes making up the interconnection matrix are welded together to form the necessary interconnections (Fig. 2). The flexible leads, or pigtailed, of the modules are not placed in the tubes and soldered in place until the final assembly stage is reached.

MODULES—Modules should be made as large and thin as possible commensurate with limiting fac-



IDEALIZED module geometry decreases number of system connections (top). Dot-or-pellet components (bottom) enable desired thinness of modules—Fig. 3



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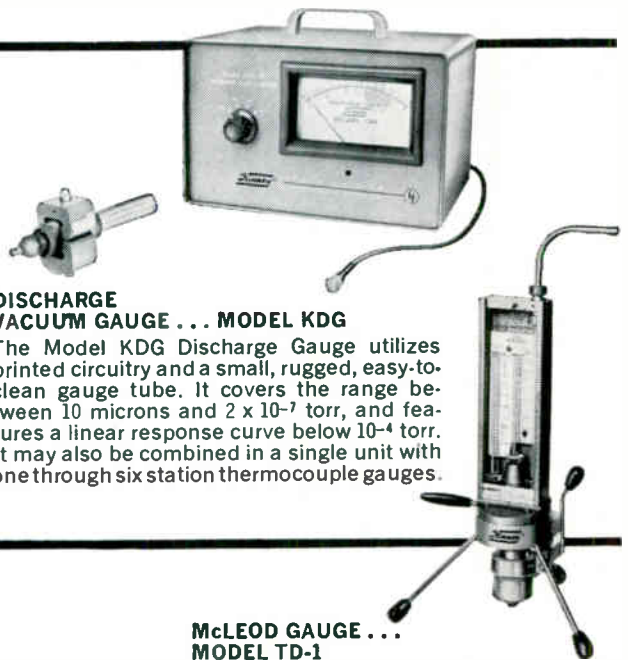
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The Model KTG Thermocouple Gauge features a transistorized control circuit and printed circuit wiring, in one through six station cabinet or panel mounted units, to indicate pressures from 3000 microns to one micron. The control unit is pre-calibrated and all thermocouple tubes are matched to allow complete interchangeability without recalibrations.



**DISCHARGE
VACUUM GAUGE . . . MODEL KDG**

The Model KDG Discharge Gauge utilizes printed circuitry and a small, rugged, easy-to-clean gauge tube. It covers the range between 10 microns and 2×10^{-7} torr, and features a linear response curve below 10^{-4} torr. It may also be combined in a single unit with one through six station thermocouple gauges.

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MODEL TD-1**

The Model TD-1 McLeod Gauge accurately indicates pressures between 150 torr and one micron, easily and without adjustment. It is light weight, sturdily constructed, and more compact than most comparable gauges and is readily disassembled for cleaning.

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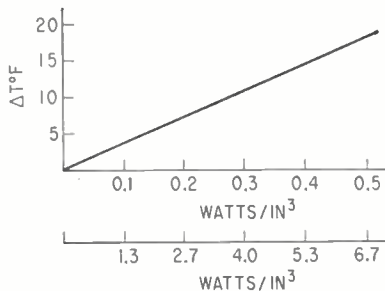
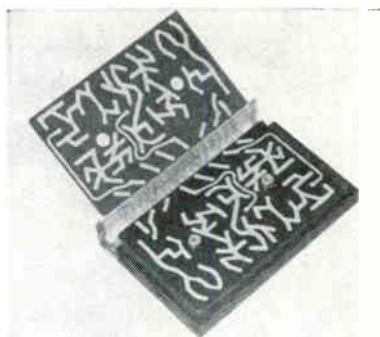
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THERMAL-TEST assembly (top) showed that with a heat-dissipation rate of 3 watts/in³, the rise within the system assembly is only 7.5 degrees F (bottom)—Fig. 4

tors such as manufacturability and cooling (Fig. 3). This helps reduce the number of necessary intraconnections and interconnections, and enables all intraconnections to be placed along one edge of each module so as to make possible the book packaging configuration. The use of dot-or-pellet components makes construction of such modules relatively simple and straightforward.

With dot-and-pellet modular construction, heat is easily removed. If the foil around the spacers is aluminum, it is virtually impossible to achieve a significant temperature rise within the assembly. This has been demonstrated by means of a thermal test assembly (Fig. 4) that detects the difference in temperature between the outer edge of a thermal spacer and the warmest region within the assembly exclusive of the heat generating parts themselves. Fig. 4 shows that with a heat-dissipation rate of 3 watts/in³, the rise within the assembly is only 7.5 degrees F.

Modules are fabricated as follows:

- Dots or pellets are placed by hand in an open mold in accord-

ance with a pattern printed on mylar and held in place by an adhesive

- The mold is then closed, turned on edge and filled with an epoxy encapsulating material
- After curing, module is removed from mold and adhesive cleaned from part terminals. To these are cemented contacts that are dot-shaped brass slugs which holds a flexible wire
- Silk screening is used to apply the conductive adhesive pattern followed by a cure. Then adhesive-backed teflon tape is applied to both sides of module, completing fabrication.

COST—Uniformity of dots or pellets will result in considerable assembly cost savings and make automated assembly a practical actuality. Automated assembly would make use of standard mounting cards that lend themselves to handling by low-cost automation machinery. The conductive adhesive process should be extremely inexpensive since many hundreds of connections can be made in a single operation using silk screening or stencil processes. Conductive adhesive connections have the added advantage of being "cold" so that parts cannot be damaged by thermal shock. Also, they are easily repaired during assembly or in the field.

Welding with Microscope



STEREO MICROSCOPES of 10-power magnification are used in resistance welding of 225 separate parts in a cigarette-pack sized package at Lockheed Missiles and Space Company

System engineering for airborne weapon systems

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Education: B.S. in E.E., M.E. or Physics. Applicants should be articulate in writing and communication as related to their responsibilities. U. S. citizenship required.

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MISSILE SYSTEM FUNCTIONAL DESIGN

Responsibilities: Determine functional design requirements for advanced air-launched missiles; the design of such systems to meet customer requirements and theoretical analysis of system performance; coordinate and assist engineering departments in the development of equipment to fulfill the system requirements.

Experience: Two years minimum in one or more of the following fields: **1.** System engineering on missile or fire control systems.

2. Field engineering on airborne fire control systems or missile systems. **3.** Test and evaluation of comparable systems. **4.** Radar systems (pulse doppler). **5.** Target tracking systems. **6.** Autopilot and control systems. **7.** Microwave systems. **8.** Digital computers. **9.** Navigation systems. **10.** Inertial components. **11.** Electrical power and armament control subsystems. **12.** Circuit design and electronic packaging.

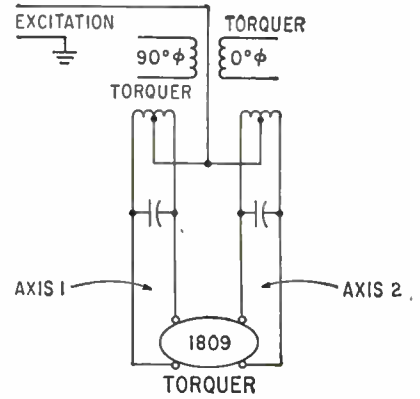
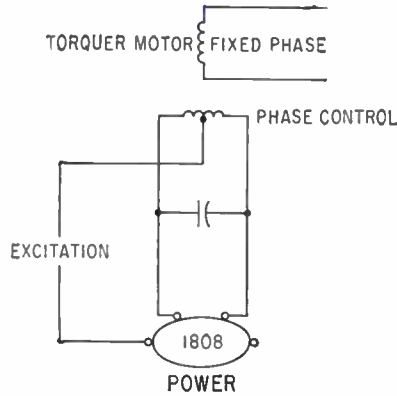
Education: B.S. in E.E., M.E. or Physics. Articulate in communications. U.S. citizenship required.



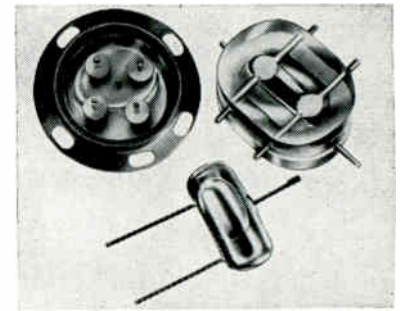
Vertical Sensors Made of Glass

Output level proportional to tilt while phase is proportional to direction

MANUFACTURED by Kearfott Div., of General Precision, Inc., 1150 McBride Ave., Little Falls, New Jersey, are a series of miniature vertical sensing elements that provide an a-c output proportional to tilt around their sensitive axes. Model C70 1808 000 is a single-axis, low-cross-coupling error, damped vertical sensor that operates in either direction from level to 1 degree. Beyond this point output increases slightly until saturation at approximately 10 degrees. From here to 170 degrees, output remains constant. When tilted to near 180 degrees, output decreases to minimum. Repeatability is approximately ± 3 arc seconds. It can drive a torquer motor without use of amplifiers and can be used as a level sensor. Model C70 1809 000 is a two-axis vertical sensor that detects angular displacement about two orthogonal horizontal axes. Mechanical tilting from true horizontal



generates an a-c signal proportional to tilt angle. Output voltage phase indicates direction of tilt while output voltage level is proportional to angular displacement. It operates from null to ± 1 degree and beyond this point output increases slightly until saturation at approximately ± 10 degrees. Output remains constant to ± 175 degrees and from here to about 180 degrees, output decreases to null. Output voltage slope around the 180-degree point is sufficiently steep to prevent element stabilization that prevents inverted gimbal erection without the necessity for a gimbal brake to restrict roll axis to ± 90 degrees. This unit can also drive torquers

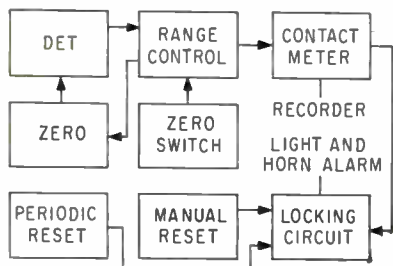


without amplification. The C70 1809 000 is approximately $\frac{1}{8} \times \frac{1}{4} \times \frac{1}{4}$ inch and weighs 5 grams. The C70 1808 000 is approximately $1\frac{1}{2}$ -in. in diameter, $\frac{7}{8}$ -in. thick and weighs 15 grams.

CIRCLE 301, READER SERVICE CARD

Lightning Warning System Gives Advance Notice

NEWLY developed by B. K. Sweeney Mfg. Co., 6300 East 44th Avenue, Denver 16, Colorado, the model SWE-1196 lightning warning system provides means of continuously monitoring and measuring atmospheric gradient conditions that



could produce lightning in the vicinity of missile and aircraft fueling or other hazardous explosive areas. Other methods, such as radar, have no value if the electrified clouds are free of precipitation and it is impossible to have a lightning stroke to earth without first having a rise in the potential gradient. Linear voltage gradient range is 0 to 5 Kv/m and 0 to 1 Kv/m, both negative and positive polarity; resolution and accuracy is 4 percent full scale; there are two readouts, a strip chart recorder and a contact meter; both audible and visual alarms are available; and the device

is fail-safe and self checking. The probe need not be mounted above the highest objects in the area and can be located as much as 50 miles or more from the control equipment. When the gradient exceeds the predetermined values, an audible alarm operates to warn of hazardous gradient conditions. (302)

Voltage-Variable Capacitor Goes to 500 pf 8 V

ON THE MARKET from Philco Corporation, Dept. PR-315, Lansdale,



The day when the designer selected his materials all by his lonesome is past—especially in electronics. Lots of engineers, from many departments, get into the electronics buying act with the design engineer today. Production engineers, for example, feel free to bare their fangs at any specified product they feel would snafu the production line. Procurement people growl for their freedom to respecify for the sake of better prices or delivery. Service engineers, once burned by a faulty component or subassembly, are twice shy and thrice loud about its inclusion in future equipment. And management's oxen are notoriously goreable. That's what makes electronics marketers turn gray. The advertiser today must

reach the design engineer *and* everyone else in electronics engineering. He can do so either through a passel of splinter publications, or through electronics.

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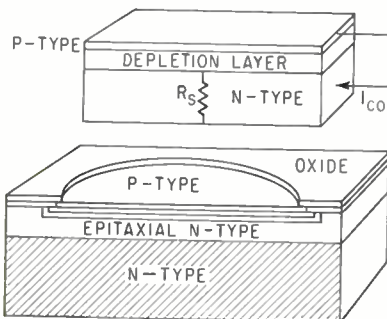
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Pennsylvania, the Voltacap voltage-variable capacitor has capacitance as high as 500 pf at 8 v, high Q and reverse breakdown voltage greater than 100 v. The type V-2853 has a capacitance of 47 pf at 8 v, maximum working voltage of 100 v and a Q of 100 at 50 Mc (8 v min). The V-2854 has a capacitance of 150 pf



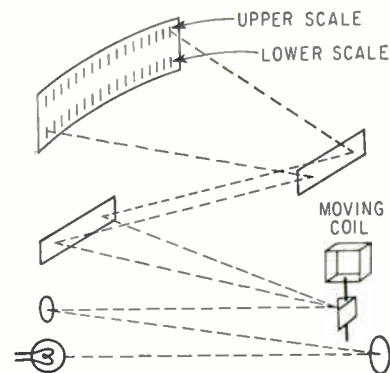
at 8 v, maximum working voltage of 100 v, and a Q of 200 at 25 Mc (8 v minimum). Devices with 8-v capacitances of 250 and 500 pf will be available in the near future. The new semiconductor combines

epitaxial growth with planar technology to control high voltage over a large semiconductor area. Design criteria (see sketch) shows use of N+ silicon layer to gain low series resistance and high Q value. An epitaxial N-type silicon of high resistivity permits high reverse breakdown voltage (large capacitance change ratio). Low leakage currents are insured by a p-n planar junction.

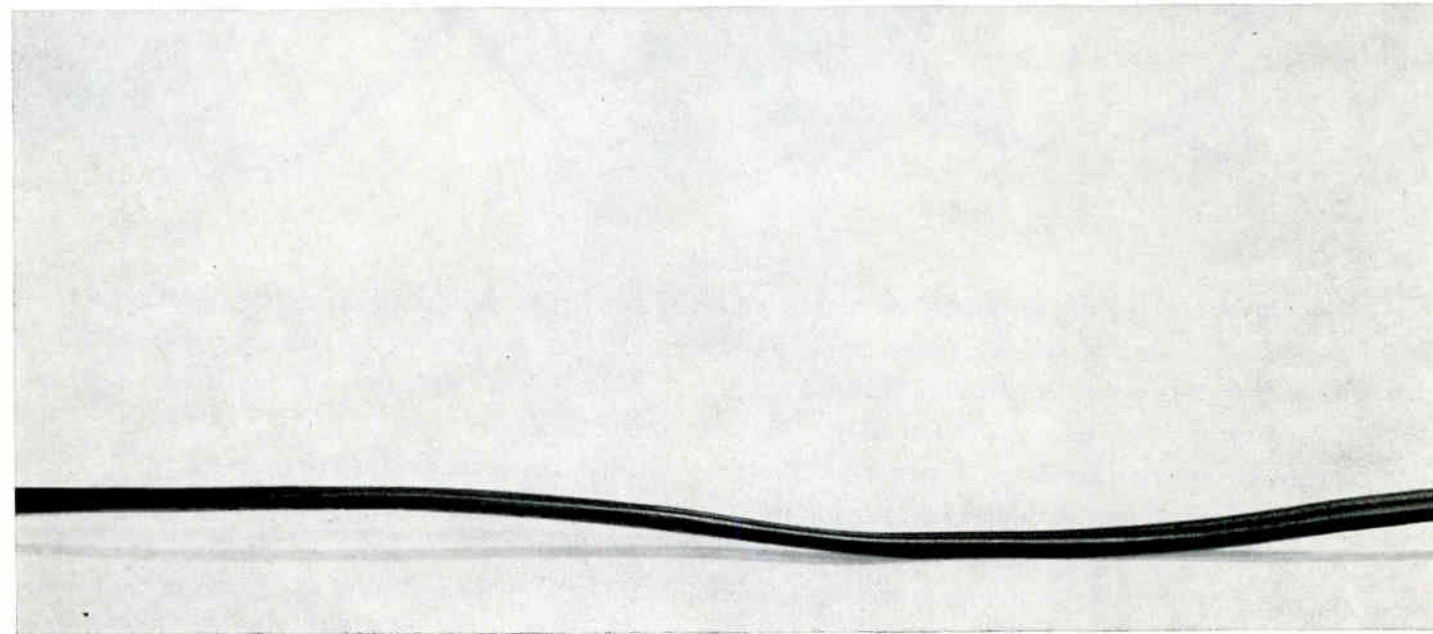
CIRCLE 303, READER SERVICE CARD

Portable Meters Use Light-Beam Principle

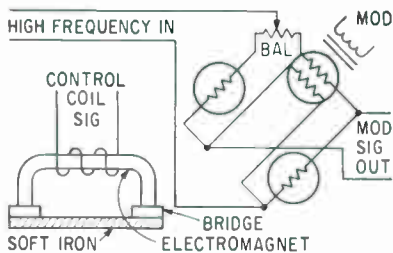
ANNOUNCED by Weston Instruments and Electronics Div., of Daystrom, Inc., 614 Freylinghuysen Ave., Newark, New Jersey, are a series of portable taut-band suspension instruments using light-beam projection. The series include wattmeters, voltmeters and ammeters. Accuracies range from 0.1 to 0.5 percent. Units are capable of full-



scale measurements from unity power factor down to 0.125 power factor and special ones are available capable of measuring 0.0125 units. The light-beam system is shown in the sketch. The beam originates from a lamp and is filtered through a condenser and object lens, deflected through two mirrors and reflected from a mirror driven from the meter moving-coil. This dual-face surface-type ground mirror splits the beam into two paths. One path scans an upper set of scale divisions while the other scans the



lower set. The beams are split by exactly one scale length and when at zero, only the upper scale is at zero. As the signal deflects the upper scale beam to full scale, the lower beam will come on scale. This system eliminates parallax error and the instrument can be read in daylight without screening. (304)



Thin-Film Integrated Wheatstone Bridge

NEW from American Aerospace Controls, Inc., 123 Milbar Blvd, Farmingdale, New York, is a thin-film integrated magnetostrictive Wheatstone bridge circuit composed

of four MistoR magnetic, flux-sensitive resistors simultaneously deposited on the same substrate. Resistance of each bridge element is between 1,250 and 5,000-ohms in five discrete values, magnetic field density is from zero to more than 50,000 gauss, bridge element current is up to 5 ma and magnetic flux sensitivity for each bridge element is 4 percent per 1,000 gauss. Applications include modulators, displacement transducers, multipliers, signal generators, computer functions and solid-state switches. Since the device is composed of high-impedance elements, high signal output voltages are attained without amplifications when appropriate a-c or d-c excitation voltages are used. The sketch shows use in a magnetic modulator. (305)

D-C/D-C Converters in Two Modular Types

BURROUGHS CORP., Plainfield, N.J., has developed a line of d-c to d-c

converters for operating Nixie tubes in electronic equipment where only low-level d-c power is available. Two modules which provide the required 170 v d-c output are converter modules VC12-170 and VC28-170. Former accepts 12 v d-c and the latter operates from 28 v d-c. The d-c to d-c converters can be used with miniature, standard, super and large Nixie indicator tubes. Voltage level conversion is obtained by means of a transistor oscillator, transformer and rectifier technique. (306)

Tantalum Capacitors Have Long Life

TANSITOR ELECTRONICS, INC., West Road, Bennington, Vt. Hermetic glass-to-metal seals between terminals and case enable type R tantalum capacitors to withstand vacuum equivalent to outer space for a minimum of 2,000 hr. The rectangular units can be completely in-



the end of the line

In just a few more years, the electric cord may become as old-fashioned as the hand crank and the kerosene lamp, for unlimited applications. Cordless power will make it so . . . the kind of power provided by Sonotone rechargeable sintered-plate, nickel-cadmium batteries. Sonotone pioneered in the field of rechargeable power, and today Sonotone batteries are used wherever high-surge/low-weight cells and batteries are required . . . in everything from Titan missiles to delicate medical instruments

to shavers and toothbrushes. If you're designing portable products, Sonotone is ready to help solve your power problems . . . no matter how difficult they may seem. Drop us a line today, stating your application requirements, and we'll send you the technical data you need. You may be surprised at how easy it is to cut the electrical cord out of your plans. **portable power for progress**

Sonotone Batteries

Battery Division, Dept. B24-43, Sonotone Corporation, Elmsford, New York
Cartridges • Speakers • Tape Heads • Microphones • Headphones • Electron Tubes • Hearing Aids • Rechargeable Batteries



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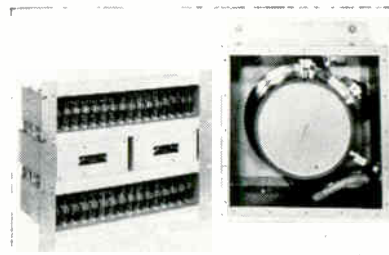
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sulated between their internal components and external cases. At 125 C capacitance varies from 3 μ f at 100 v d-c in the smallest sized non-polar unit to 3,500 μ f at 10 v d-c in the largest sized polar unit. Size ranges from $\frac{3}{4}$ in. by $\frac{3}{4}$ in. by $\frac{1}{2}$ in. to 1 $\frac{1}{8}$ in. by $\frac{3}{4}$ in. by 2 $\frac{1}{2}$ in.

CIRCLE 307, READER SERVICE CARD



Delay/Memory System For Process Control

ELECTRON OHIO, INC., 1111 Power Ave., Cleveland 14, O. An expanded 15 channel magnetic drum delay/memory system is available for process control to store, delay and release data in operations in which the product is in motion during manufacture, inspection or distribution. Speed range is from a low of $\frac{1}{2}$ rpm to a present high of 600 rpm, thus providing long delays with close resolution. Recording and read heads do not contact the drum and are adjustable around circumference of drum permitting infinitely variable delays. (308)



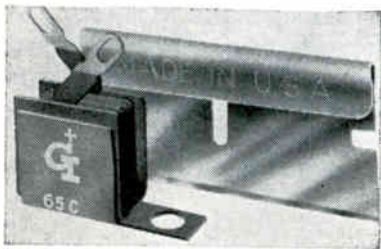
Logic Power Supply Operates from -20 to 90 C

PACIFIC COMMUNICATIONS & ELECTRONICS, INC., 3102 Rolison Road, Redwood City, Calif. The all silicon series 3150 power supplies operate at temperatures of -20 C to 90 C without forced air cooling. All of the regulated voltage sources and loads for data processing assemblies mount in the shelf with the data equipment. A typical model provides +12 v at 3.5 amp, -12 v

at 0.5 amp and +4 v load at 2.0 amp with better than 1 percent regulation for line, load and temperature. Price is \$635. (309)

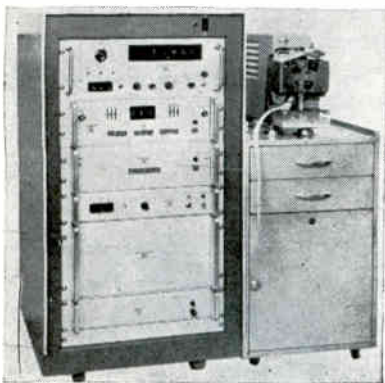
Relays

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Half-size two-pole and the four-pole Unimites feature isolated contact chambers and excellent environmental characteristics similar to the earlier and proved single-pole Unimite. (310)



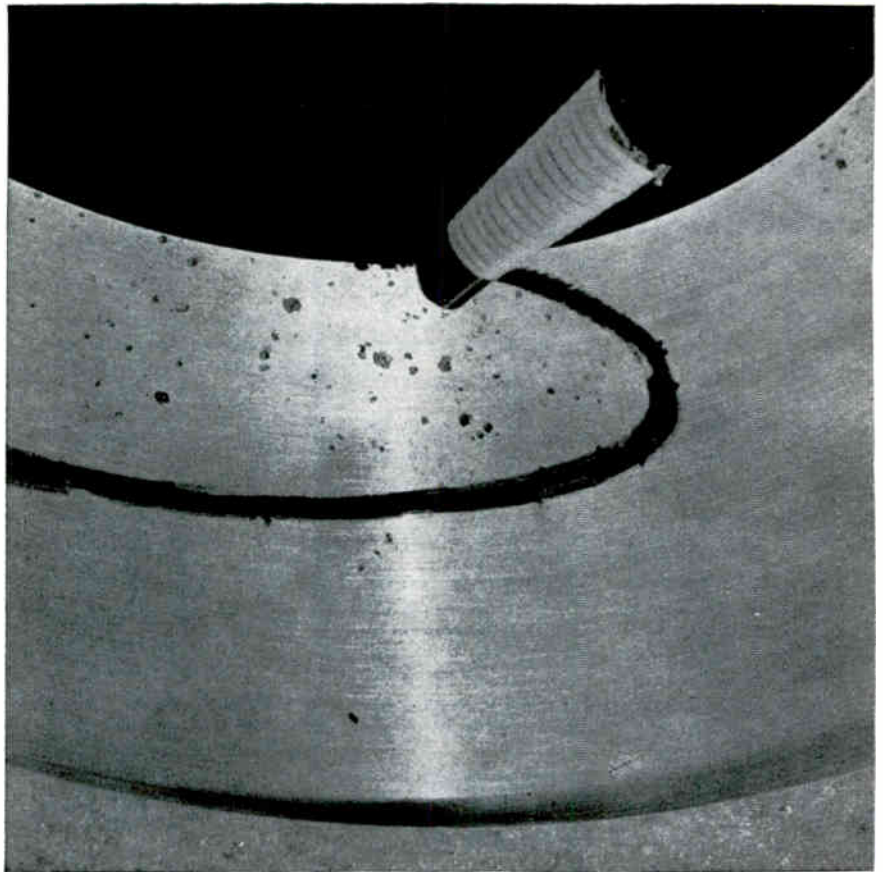
Selenium Rectifier Features Small Size

RECTIFIER DIVISION, General Instrument Corp., 65 Gouverneur St., Newark 4, N. J., offers a low-cost, small-sized 65 ma selenium rectifier primarily intended for rectification of line voltage. Device is 0.375 in. thick and less than an inch long and wide. It incorporates a mounting bracket for easy bolting or riveting to the chassis. Maximum prv of the type GI65C is 380 v and max rms input voltage is 130 v. (311)



Digital System Logs Millivolt Signals

DYMEC DIVISION, Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif., announces a digital data acquisition system designed to accu-



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*If you machine into a flaw in a
Morris Bean casting, we'll
replace the casting and pay you
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Magneline®
THE INDICATOR WITH INHERENT MEMORY

Two new series for digital readout, ideal for multiplex applications

SERIES 14000—FOR SOLID STATE LOGIC

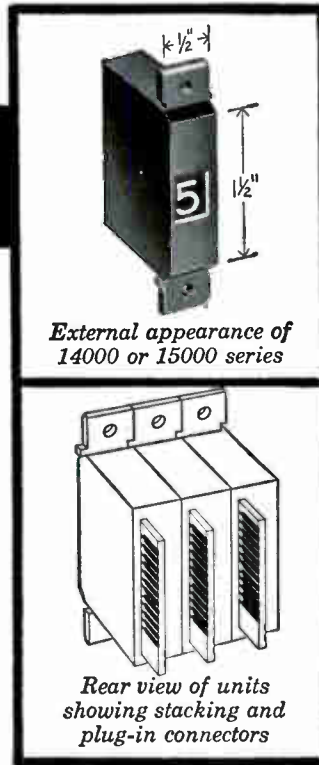
Character Size..... $\frac{9}{32}$ " x $\frac{1}{4}$ "
No. of Characters.....Up to 11
Leads.....11 plus a common
Watts.....2.4

SERIES 15000—FOR RELAY LOGIC

Character Size..... $\frac{5}{16}$ " x $\frac{1}{4}$ "
No. of Characters.....Up to 10
Leads.....5 plus a common*
Watts.....1.3-1.7

*Requires switching of lead in combination with reversal of polarity to change indicator.

Units hold last reading without power. Totally enclosed, self-stacking housing for front or rear mounting. Jewel bearings, only one moving part. Standard voltages 6, 12, 24, or 28 V.D.C. Readability 12 feet at normal room lighting. Options include special voltage, special characters, and internal lighting for dark room applications.



External appearance of 14000 or 15000 series

Rear view of units showing stacking and plug-in connectors

rately measure and record information produced by multiple millivolt-level signal sources, such as thermocouples and strain gage bridges. The DY-2010G thermocouple/strain gage bridge measuring system provides high accuracy measurements in the presence of severe common mode noise. Floated and guarded input scanner, amplifier and digital voltmeter assures better than 120 db effective common mode rejection at all noise frequencies including d-c.

CIRCLE 312, READER SERVICE CARD

I-F Amplifier Has Compact Design

INSTRUMENTS FOR INDUSTRY, INC., Hicksville, L.I., N.Y. A 30-Mc transistorized i-f amplifier, designed for maximum compactness, maintains gain stability within 3 db, from -45 C to 72 C. (313)



High Potential Tester Features Reliability

PESCHEL INSTRUMENTS INC., Route 216, Towners, Patterson, N.Y. Model S5 h-v d-c Hipot tester features both voltage and current meters, continuously adjustable output from 0 to 5,000 v d-c, with self-protecting circuit and automatically current limited to a safe value of 5 ma. It is ideal for impulse testing and capacitor charging. Price is \$179. (314)



Actuator Has Only One Moving Part

THERMAL HYDRAULICS, INC., 517 West 40th Ave., Denver, Colo. The

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for free literature

PATWIN® ELECTRONICS
A DIVISION OF THE PATENT BUTTON COMPANY
WATERBURY 20, CONNECTICUT

CIRCLE 202 ON READER SERVICE CARD

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BARS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SHEETS	✓				✓	✓	✓	✓	✓	✓	✓
WIRE	✓				✓		✓	✓		✓	✓
POWDER		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SHOT		✓		✓	✓	✓	✓	✓	✓	✓	✓
ROD	✓			✓	✓		✓	✓	✓	✓	✓
RIBBON							✓	✓			
PRE-FORMS	✓					✓	✓	✓	✓	✓	✓
SALTS						✓	✓				

COMINCO PRODUCTS, INC.

electronic materials division

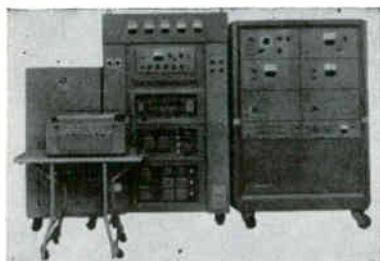
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3402

66 CIRCLE 66 ON READER SERVICE CARD

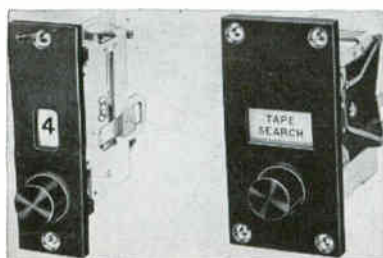
April 5, 1963 • electronics

500 series actuator comes with a choice of two cases, anodized aluminum or brass. The stroke, at 30 w input, is from 0 to ½ in. Unit can be used with four different operating voltages—6, 12, 24 and 28 v, a-c or d-c. Thrust of the output shaft is as high as 250 lb. This type of actuator is suited for valve actuation, modulation, linear actuators, hold down, latching, unlocking, and various control applications. (315)



Hysteresis Loop Tracer For Magnetic Materials

YOKOGAWA ELECTRIC WORKS, INC., 40 Worth St., New York 13, N. Y. Model SRB-32 magnetic hysteresis loop tracer is designed for graphical analysis of soft magnetic materials. It traces automatically on 7 in. by 9½ in. charts: (1) magnetic hysteresis curve (B-H curve), and (2) waveforms of magnetizing force, induction and induced voltage. A complete B-H curve is recorded in 30 seconds. Curves are traced at desired frequencies between 50 cps and 10 Kc. Plottings are within an accuracy of ±2 percent. (316)



Pushbutton Switches In Compact Design

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill., announces multifunction 10-position digital and binary modular pushbutton switches. Each pc module is manually operated by simply pressing a "O" ring sealed pushbutton. Panel portions of ex-



'The New NEMS-CLARKE® 'Receiver Is Easy To Change!

- 1. Solid State and NuvistORIZED
- 2. Modularized construction
- 3. Plug-in Spectrum Display
- 4. Meets IRIG Standards
- 5. Provides All Standard Modulation Modes

The new 1037 solid state modularized receiver with plug-in front end modules reduces obsolescence and affords complete frequency coverage of all authorized telemetry bands. Modular RF Tuners are available covering frequency range from 55 to 2350 mc; all IRIG IF bandwidths from 12.5 kc to 1.5 mc are available with individually matched FM discriminators. Phase lock FM demodulation and synchronous PM and AM demodulation can be added. Send today for a free brochure on the newest and most easy-to-change telemetry receiver: The Nems-Clarke 1037.



For further information, write: Dept. 550 Vitro Electronics, 919 Jesup-Blair Drive, Silver Spring, Maryland. Sales Offices: Houston and Los Angeles A Division of Vitro Corporation of America

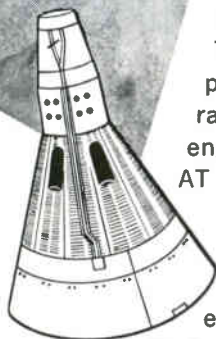
VITRO ELECTRONICS

Specifications:

- 1. Nine plug-in front ends . . . (55-2350 mc)
- 2. IF bandwidths . . . 12.5, 25, 50, 100, 300, 500, 750, 1000, 1500 kc standard.
- 3. Video Filter . . . selectable cut-off frequencies of 12.5, 25, 50, 100, 300, 500, 1000 kc; attenuation slope 18db/octave
- 4. Demodulation FM and AM Standard; PM, Synchronous AM, and phase lock FM can be added.

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ENGINEERS WHO
KNOW THEIR WAY
AROUND IN SPACE!**

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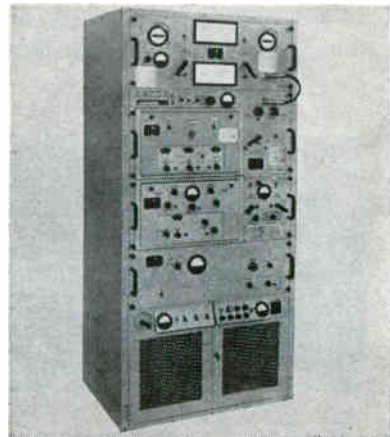
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posed switch are completely sealed against dust and are drip and splash proof. Two widths are available, one requiring only 1 in. panel space for digital or alpha readouts, the other 1½ in. panel space for function readout. Prices begin at \$24.00.

CIRCLE 317, READER SERVICE CARD



Transmitter with a Range of 2 to 30 Mc

MARS ELECTRONICS, Syosset, L.I., N.Y. The TR-302 is a 500-w transmitter capable of delivering full power for c-w radio telegraph, frequency shift telegraph, modulated c-w telegraph, facsimile or radio telephone over its entire frequency range. Unit may be obtained with either a synthesized variable frequency oscillator or a conventional vfo. All models have 10 crystal controlled channels. (318)



Pressure Transducer Has Long Life

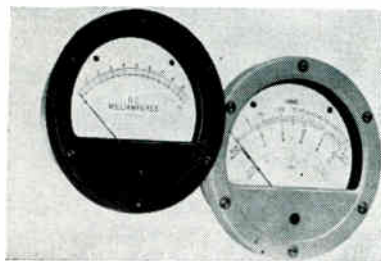
COMPUTER INSTRUMENTS CORP., 92 Madison Ave., Hempstead, L. I., N. Y. Model 4000 carbon-film pressure transducer, with prices starting at \$125, was designed for industrial and commercial applications. It offers life in excess of 3 million cycles, depending upon cir-

cuity, with repeatability at least 10 times better than comparably priced units. Linearity can be as good as ± 0.3 percent, according to need. Practically impervious to temperature changes, the operating range is -55 C to $+85$ C. Unit can meet vibration specifications up to 5 g and 2,000 cycles; and withstand 50 g shock for 11 msec. (319)



Guard Rail Cart for Test Equipment

LAKESIDE MFG., INC., 1977 South Allis St., Milwaukee 7, Wisc. The heavy duty guard rail cart has Springlide casters. The Springlide, a 5 in. diameter rubber-tired wheel, is designed with a rear spray that absorbs most jar and vibrations during transporting delicate equipment. Cart is available in shelf sizes from 18 in. by 27 in. to 21 in. by 33 in. in a choice of 4 models. Prices start at \$121.25. (320)



Panel Meters Are Ruggedized, Sealed

WACLIN METERS, 35 S. St. Clair St., Dayton 2, O., offers standard and custom manufactured $4\frac{1}{2}$ in. round, ruggedized and sealed electrical indicating panel meters suitable for a wide variety of military and commercial uses. Standard meters conform to MIL-M-10304 for size, performance and reliability. Custom meters are manufactured to similar specifications, and are tailored to meet the particular requirements of each individual user. (321)

SUPERIOR SUPPLIES CATHODES FOR EVERY ENGINEER'S REQUIREMENTS

		
I want high-purity nickel	I want round shape	I want square shape
		
I want king size	I want active	I want passive
		
I want all-purpose	I want high strength	Which kind do you want?

Whatever kind of cathodes you need, Superior can supply them. For all sizes of receiving tubes, transmitting tubes, special purpose tubes. Seamless, WELDRAWN,[®] Lockseam,^{*} laseam. Choice of over 25 different alloys. Shaped, beaded or tabbed. Disc cathodes in standard, miniature and subminiature sizes. Quality is unmatched. Fast delivery. Write for selector guide. Superior Tube Co., 2500 Germantown Avenue, Norristown, Pa. ^{*}Manufactured under U.S. patents

Superior Tube

The big name in small tubing
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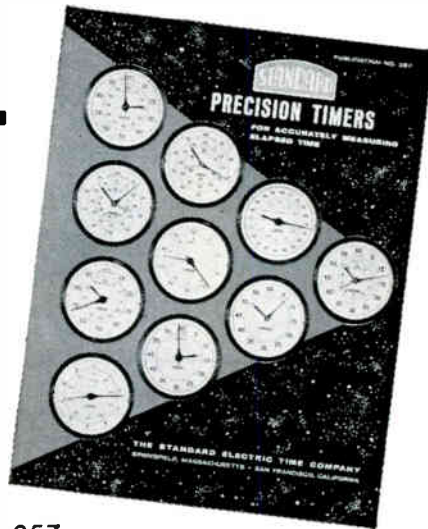
Johnson & Hoffman Mfg. Corp., Mineola, N.Y.

—an affiliated company making precision metal stampings and deep-drawn parts

PRECISION TIMING A PROBLEM?

HERE'S HELP...

New, complete catalog describes full line of Standard precision timers. Various models have scale divisions from 1/1000 sec. to 1/5 sec., totalize from .360 sec. to 60 min., are available in accuracy range from $\pm .0002$ sec. to ± 1 sec.



REQUEST Catalog No. 257



—THE ONE TIMER WITH ALL THE FEATURES

THE STANDARD ELECTRIC TIME COMPANY

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CIRCLE 203 ON READER SERVICE CARD

NEW

HIGH VOLTAGE POWER SUPPLIES



PSR Series, pictured above offer these important features: Range 5 to 30 KV, 2 to 30 MA • Regulation $\pm .05\%$ • Ripple .1% RMS • Completely Solid State Circuitry • Light Weight • Rack Height 8 $\frac{3}{4}$ " maximum • Dry Insulation • Overload Protection • Reversible Polarity • Simplified Controls; coarse and fine voltage, ON-OFF meter reversing switch • Triple-Range Kilovoltmeter and Milliammeter. Write for New 1963 High Voltage Bulletin.

ELECTRONICS DIVISION

RESEARCH-COTTRELL, INC., BOUND BROOK, NEW JERSEY

Literature of the Week

PROTECTIVE COATINGS Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway West, Woodside 77, N. Y. The 1963 HumiSeal index conveniently lists different applications of protective materials.
CIRCLE 322, READER SERVICE CARD

MINIATURE BELLOWS COUPLINGS Nilsen Mfg. Co., P. O. Box 127 Haines City, Fla., has available a data sheet describing a series of miniature bellows couplings for precision instrument drives. (323)

TWT AMPLIFIERS American Electronic Laboratories, Inc., 301 Richardson Road, Colmar, Pa. Bulletin 62-49 describes five types of traveling wave tube amplifiers (four octave band and one very broad band unit). (324)

COMPUTER EVALUATION PROGRAM Compress, Inc., 2916 V St., N. E., Washington 18, D. C. has published a brochure announcing SCERT, a new EDP Systems and Computers Evaluation and Review Technique. (325)

DATA REDUCTION SYSTEM The Gerber Scientific Instrument Co., P. O. Box 305, Hartford, Conn. Model GADRS-4 data reduction system is the subject of a new folder. (326)

MAGNETOSTRICTIVE DELAY LINES Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn., has published a brochure on magnetostrictive delay lines to aid digital circuit engineers. (327)

R-F AMPLIFIER Microwave Cavity Laboratories, Inc., 10 North Beach Ave., LaGrange, Ill., has published a data sheet on a tetrode cavity amplifier for use in the 400-450 Mc frequency range. (328)

RESISTORS CTS of Berne, Inc., Berne, Ind. A 12-page catalog features the complete line of Cermet high temperature variable and microminiature fixed resistors. (329)

COMPONENT OVENS Control Indicating Corp., Spring St. and Route 75, Windsor Locks, Conn. Technical bulletin gives complete data on series PC proportional control component ovens. (330)

SILICON TRANSISTOR OSCILLATOR Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif., offers a bulletin on model C-110 crystal and heater controlled silicon transistor oscillator. (331)

PERMANENT MAGNET MANUAL General Electric Co., Schenectady 5, N. Y., offers PM-200, a 40-page illustrated brochure on the theory, characteristics, design and application of permanent magnets. (332)

COMPUTER BROCHURES Digital Equipment Corp., 146 Main St., Maynard, Mass. Two brochures describe a general purpose, high speed, solid

state computer and a systems-type computer for inter-device information control. (333)

CODE FORMAT CONVERTER Frederick Electronics Corp., 414 Pine Ave., Frederick, Md. Product data sheet illustrates and describes model 660 code format converter. (334)

A/D CONVERTER Systems Engineering Laboratories, Inc., 4066 Northeast Fifth Ave., Fort Lauderdale, Fla. Bulletin covers the ADC-1B analog-to-digital converter. (335)

STEP-SERVO MOTORS IMC Magnetics Corp., 6058 Walker Ave., Maywood, Calif. A 10-page booklet describes theory and operation of incremental step-servo motors. (336)

GAS LASERS Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., is offering a brochure describing its line of continuous wave gas lasers. (337)

CAPACITORS Dearborn Electronic Laboratories Inc., P. O. Box 3431, Orlando, Fla., has available a short-form data describing miniature, plastic dielectric, tubular, fixed capacitors meeting MIL-C-27287 (USAF). (338)

ENAMELED WIRE TESTING Brinkmann Instruments, Inc., 115 Cutter Mill Road, Great Neck, L. I., N. Y., has available a bulletin describing the Phywe Fault Counter and other testing and supervisory equipment for enameled wire. (339)

INSTRUMENT SERVOS North Atlantic Industries, Inc., Terminal Drive, Plainview, N. Y. Technical bulletin TB-103 is a state-of-art survey on servo data conversion. (340)

FILTER Microwave Development Laboratories, Inc., 15 Strathmore Road, Natick Industrial Centre, Natick, Mass. Data sheet illustrates and describes the WR137 two-cavity directional filter. (341)

SERVO MOTOR CATALOG Bowmar Instrument Corp., 8000 Bluffton Road, Fort Wayne, Ind. A 6-page short-form catalog provides detailed specifications dimension drawings and photo illustrations for 34 servo motors and motor-gearhead combinations. (342)

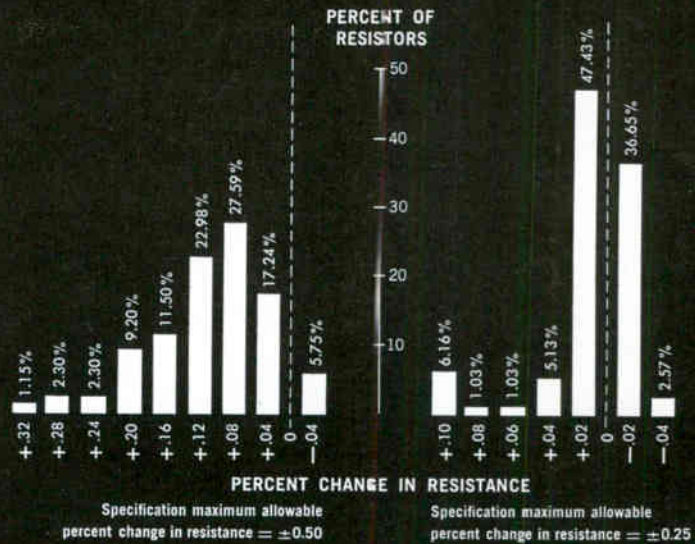
INFRARED TRANSMITTING GLASS Kollmorgen Corp., Northampton, Mass. Product bulletin No. 105 illustrates and describes Barr and Stroud calcium aluminate infrared transmitting glass. (343)

ELECTRIC OVEN Gruenberg Electric Co., Inc., 9 Commercial Ave., Garden City, N. Y., offers a bulletin describing an electric oven for paint drying, plastic curing, annealing and general baking where low heat is required. (344)

CRYSTAL FILTERS Hill Electronics, Inc., Mechanicsburg, Pa. Bulletin F-101 gives technical specifications on the 475-000 series of crystal filters with center frequencies of around 1.75 Mc. (345)

MOISTURE RESISTANCE TEST
per MIL-R-10509D Characteristics C and E

TEMPERATURE CYCLING TEST
per MIL-R-10509D Characteristics C and E



METOHM—charts new plateaus in metal film resistor performance

Ward Leonard reports unmatched test results

Top reliability in metal film precision resistors—highest known today—is proved in Ward Leonard's new Bulletin 50A. Ward Leonard tested over 700 resistors over a 12 month period to document these results.

Example: take two critical tests (of the 22 run)—moisture resistance and temperature cycling.

Here's the MIL Spec and the Ward Leonard Result—

Test	MIL-R-10509D Maximum Deviation	METOHM Performance
Moisture Resistance	±0.5%	-0.04 to +0.32
Temperature Cycling	±0.25%	-0.04 to +0.10

Other rigorous tests such as vibration, load life and shock show equally impressive results. In addition, each METOHM® resistor logs 7 inspections, 8 quality-control checks, and 7 tests prescribed by MIL-R-10509D and MIL-STD 202B specifications.

Write for Bulletin 50A and ask for samples—available in these ratings: RN55-1/10 W; RN60-1/8 W; RN65-1/4 W; RN70-1/2 W.

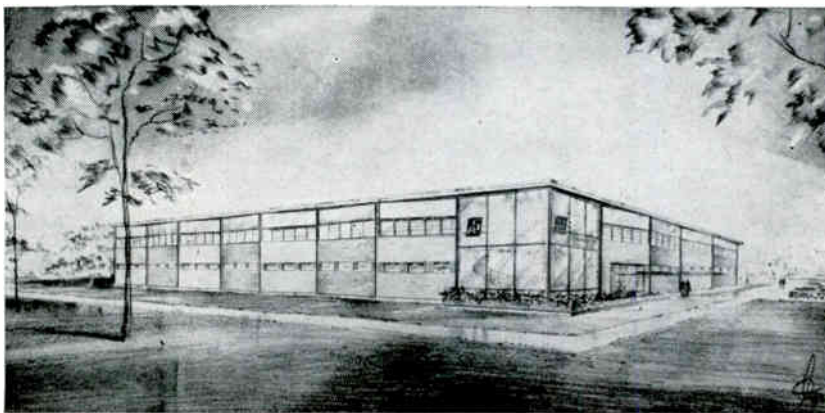
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METAL FILM DIVISION
WARD LEONARD
ELECTRIC CO. MOUNT VERNON
NEW YORK
RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS

Sanders Erecting New Facility



SANDERS ASSOCIATES, INC., Nashua, N.H., has begun construction of a 50,000 square foot facility in Bedford, Mass. A versatile two-story plant is designed to accommodate R&D and manufacturing operations, and is scheduled for completion by August, 1963, president Royden C. Sanders, Jr., announced.

Manufacturing operations at the plant will include new production programs of Sanders - developed electronic weapon systems. These programs will be phased into production as the projects develop.

Two advanced engineering groups will also be headquartered in the new plant. The Advanced Systems Laboratories and the Corporate Advanced Program Development group, presently located in

leased quarters at Burlington, Mass., will move into the plant by late summer.

The Sanders/Bedford facility is the third new plant to be built in three years in a program of rapid expansion. During this 3-year period the company's sales volume has climbed from about \$17 million in 1960 to a current annual rate of about \$60 million.

The 12-acre land site owned by Sanders provides room for future expansion. It will accommodate up to 200,000 square feet of plant space plus supporting facilities, Sanders pointed out. Plant layout of the new facility is flexible to allow adding new sections just as fast as the need develops, he said.

The missile-electronics company has as its headquarters a 500,000

square foot plant in Nashua, N.H., a manufacturing facility at Manchester, N.H., and the Geospace Electronics division at Plainview, L.I., N.Y.

Announce Formation of New Company

FORMATION of Microphysics Inc., a new company devoted to the application of microminiature techniques to industrial and consumer products as well as military and electronic items, is announced by Franklin Meyer, former president and board chairman of Tempo Instrument Inc.

The new company has its headquarters in Huntington, N.Y. Meyer is its president.



National Company Names Finke

HERBERT A. FINKE has been named president and chief executive officer of National Company, Inc., Malden, Mass. He will also serve as a member of the executive committee of which Louis C. Lerner is chairman.

Finke was formerly vice president of Varian Associates, Inc., Bomac division, of Beverly, Mass.

Davis to Receive EIA Medal of Honor



L. BERKLEY DAVIS, a vice president of the General Electric Co. and general manager of its Electronic Components division at Owensboro, Ky., has been named to receive the Electronic Industries As-

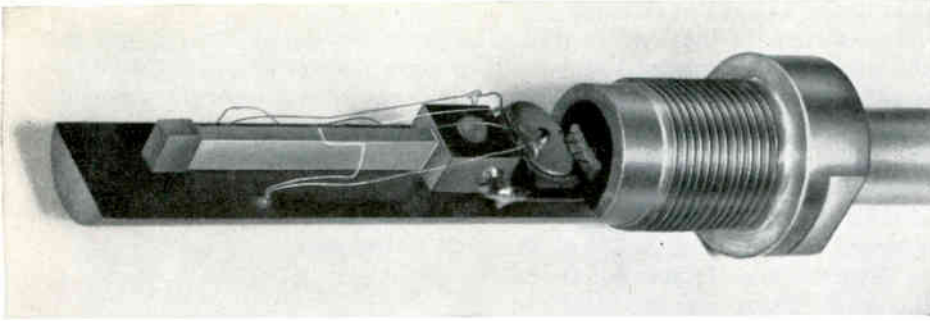
sociation's highest award, the EIA Medal of Honor.

Presentation of the medal, given annually since 1952 for "distinguished service contributing to the advancement of the electronics industry", will be made June 19 at an annual Award Dinner during the Association's 39th Annual Convention in Chicago.

Davis was first elected president of EIA in 1960. He was chosen for a second term the following year and recently has played a leading role in Association efforts to assist the Department of Defense in developing reliability specifications for military electronics.

Avco Acquires New Space Facility

AVCO CORPORATION'S Research and Advanced Development division, Wilmington, Mass., has purchased the recently vacated Raytheon plant in Lowell, Mass. The 200,000-sq ft



An elegant, but tiny refrigerator, utilizing the Nernst-Ettingshausen effect, has been demonstrated in the Solid State Physics Laboratories at Lockheed Missiles & Space Company. This type of cooling is applicable below 200° Kelvin, where thermoelectric cooling is no longer efficient. It shows particular promise for space application because of the reliability inherent in its all-solid state construction.

In the Nernst-Ettingshausen effect, heat is pumped as a result of an electrical current flowing in a magnetic field. The heart of the present device is a bismuth antimony single crystal. Other crystal systems are also being investigated.

This thermomagnetic cooling device is one of the results of the Lockheed research program in transport phenomena in solids.

Another investigation concerns the quantum theory of the electronic structure of crystals. An ingenious computer program has been devised for determining the essential features of the energy band structure of a wide variety of crystals. Results for a given case can be obtained in an hour or less. Conclusions drawn from the theoretical solution elucidate many of the electronic properties of crystals, and have widespread significance.

Lockheed scientists and engineers are also studying: Electron spin echo phenomena; the interaction of electrons with microwave phonons; coupled traveling waves in crystals; semiconductor lasers; antiferromagnetic resonance; various theoretical and experimental aspects of superconductivity.

LOOK AT LOCKHEED...AS A CAREER

Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile, the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-45A, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to solid state physicists and chemists, other important openings exist for specialists in: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical & nuclear propulsion • Systems engineering • Computer research

LOCKHEED

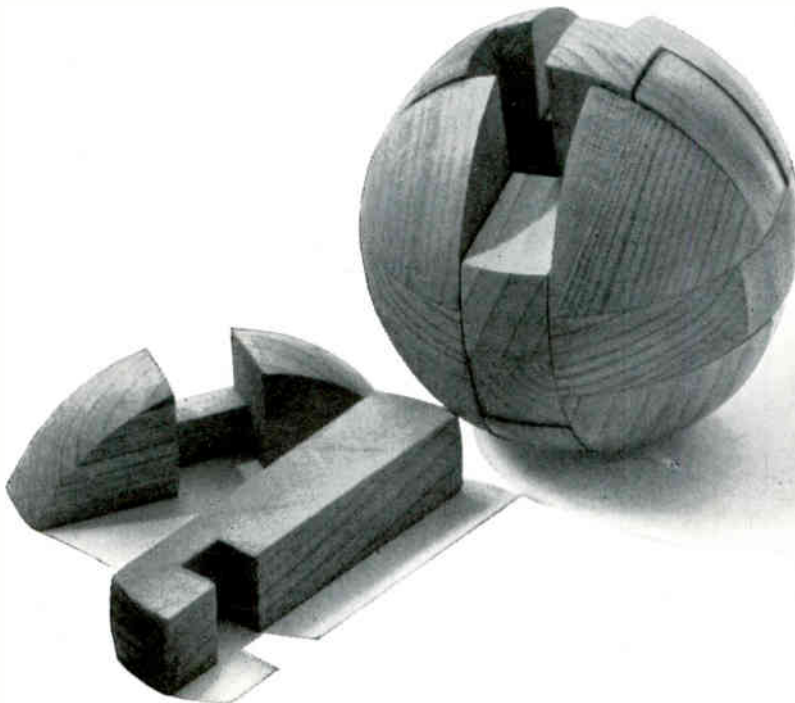
MISSILES & SPACE COMPANY

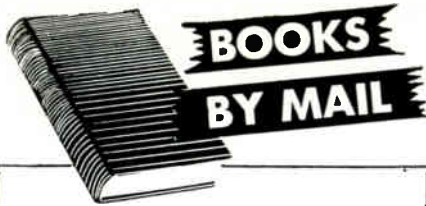
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Sunnyvale, Palo Alto, Van Nuys, Santa Cruz, Santa Maria, California • Cape Canaveral, Florida • Huntsville, Alabama • Hawaii

LOOK AT LOCKHEED IN SOLID STATE PHYSICS:

Basic and applied research on the properties of solids





OSCILLATIONS IN NONLINEAR SYSTEMS

Just Out. Deals with the theory of nonlinear oscillations for ordinary differential equations containing a small parameter. Gives a unified approach for obtaining periodic solutions of non-autonomous and autonomous differential equations. By J. K. Hale, Research Inst. for Adv. Studies. 192 pp., illus., \$9.00

ELECTRONIC PROCESSES IN MATERIALS

Just Out. Unified approach, discussing properties based on electronic interaction in solids. Stresses the role of electrons and their behavior in various crystal structures and points out the common features of many phenomena. By L. V. Azaroff and J. Brophy, both of Illinois Inst. of Tech. 480 pp. illus., \$10.75

PLASMA PHYSICS AND MAGNETOFLUIDMECHANICS

Just Out. Coordinates the many different aspects of plasma physics and magnetofluidmechanics in a systematic and interdisciplinary manner. Especially applicable in the areas of energy conversions, propulsion, and gasdynamics of electrically conducting gases. By A. B. Cambel, Northwestern Univ. 320 pp., illus., \$11.50

TUNNEL-DIODE AND SEMICONDUCTOR CIRCUITS

Practical treatment of the theory and application of semiconductor devices other than conventional transistors and diodes. Includes semiconductor circuits applied to microminiaturization of electronic equipment. Practical circuits are given, with component values. By J. M. Carroll, Electronics. 384 pp., 8-3/8 x 11, illus., \$9.75

Exploring THE UNIVERSE

Just Published. This exciting and thought-provoking work presents the comments of 53 eminent scientists, scholars, and science writers, both ancient and modern—ranging from Aristotle to Einstein, Conant, and Huxley—on vital scientific subjects. Discusses such questions as How Was the Universe Made? Is There Other Life In It? Why Are We Exploring Space? Helps develop a truly mature understanding of the individual's role in the New Age of Science. Prepared by American Foundation for Continuing Education. 457 pp., 7 x 10, illus., \$6.95

10 DAYS' FREE EXAMINATION DIRECT FROM PUBLISHER

McGraw-Hill Book Co., Inc., Dept. L-4-5
327 W. 41st St., N. Y. C. 36
Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privileges.)

- Hale—Oscillations in Nonlin. Sys., \$9.00
- Azaroff & Brophy—Electronic Proc. in Matts., \$10.75
- Cambel—Plasma Phys. & Magneto-fluidmech., \$11.50
- Carroll—Tunnel-Diode & Semicon. Circ., \$9.75
- Amer. Found. for Con. Educ.—Exploring the Universe, \$6.95

(PRINT)

Name

Address

CityZoneState

Company

Position

For price and terms outside U. S.

Write McGraw-Hill Int'l., N. Y. C. L-4-5

building is adjacent to another Avco unit in the Lowell Industrial Park.

In addition to the new facility, the division has in the last year leased 150,000 sq ft in Lawrence; acquired 110,000 sq ft in Lowell, and added 70,000 sq ft in Wilmington to its headquarters. The Avco-Everett Research Laboratory has acquired an additional 33,750 sq ft in Everett and 11,200 sq ft in Haverhill. These plus the most recent announcement bring Avco's total space in the Boston area to over a million square feet.

Employment at the Research and Advanced Development division has grown in the past year from 3,130 to 4,342 persons. Of this increase, approximately 300 persons are working on research and engineering aspects of Avco's space programs.

San Francisco Western Region headquarters.

In his new post, Bandes will supervise the activities of the firm's three research groups. They are advanced research headed by Oskar Heil, special studies headed by Donald H. Preist and the process and materials laboratory headed by Robert Culbertson.



ITT Names Wing a Vice President

INTERNATIONAL Telephone and Telegraph Corp. announces the election by the board of directors of A. K. Wing, Jr., as vice president-engineering of the ITT Electron Tube division.

Wing formerly was technical director-communications for ITT Federal Laboratories and has been associated with the ITT System for 22 years.



Frequency Electronics Elects John Ho

JOHN C. HO, formerly chief engineer, has been elected to the newly created post of vice president in charge of research and development at Frequency Electronics, Inc., Astoria, N. Y.

In his new position, Ho assumes full responsibility for development of quartz crystal controlled oscillators, proportional controlled ovens and complete frequency and timing control systems for military and industrial applications.



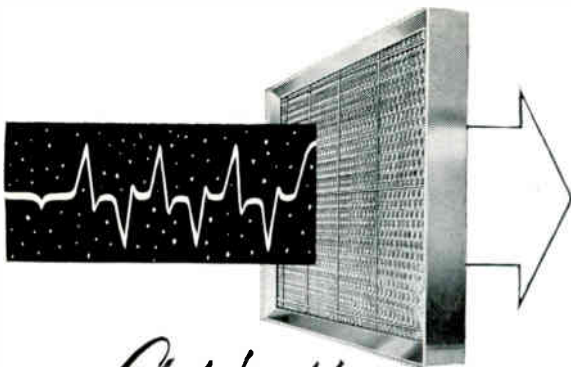
Rauland Corporation Hires Gleichauf

PAUL H. GLEICHAUF has joined The Rauland Corp., a wholly-owned subsidiary of Zenith Radio Corp., Chicago, Ill., as manager of the monochrome cathode ray tube research and development department.

Prior to joining Rauland, Gleichauf was with the General Electric Company's Electronics Laboratory in Syracuse, N.Y., for a period of

Eitel-McCullough Appoints Bandes

HERBERT BANDES has been appointed director of research for Eitel-McCullough, Inc., San Carlos, Calif., electron power tube developers. He was formerly senior staff member with Arthur D. Little, Inc., at the



Get both
**RF SHIELDING and
 THOROUGH AIR CLEANING**

Now... any electronic package can be equipped with an air window that provides both RF shielding and air cleaning. Available in practically any size... all aluminum... washable and permanent. E Z Kleen Air Filters permit maximum air flow and minimum restriction. Ventilating air is scrubbed clean... and attenuation in excess of 50 db at 10,000 mc/s and in excess of 40 db at 1000, 10 and 1 mc/s is attained. Write for information.



RESEARCH PRODUCTS Corporation Dept. 241-D, Madison 1, Wis.
CIRCLE 204 ON READER SERVICE CARD

- NO Springs
- NO Wiring
- NO Soldering
- NO Mechanical Linkage
- NO Exposed Parts

AN ENTIRELY NEW
 RELAY DESIGN



Printact® PERMANENT MAGNET
 PRINTED CIRCUIT
 PLUG-IN RELAY

PLATED CONDUCTORS ON YOUR PC BOARD
 ARE THE FIXED CONTACTS

Many leading electronic OEMs are now saving SPACE, MONEY and MANHOURS with this new small, light weight, highly reliable PRINTACT Relay.

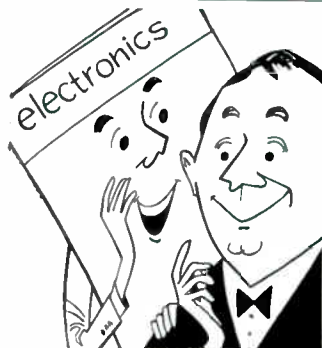
Available with Bifurcated Palladium, Gold-Alloy or Silver contacts for more than 5 million cycle 1, 2 or 3-pole switching. Handles up to 2 amp. res. loads. Coils from 20 to 10K ohms at 500 mw. Operating temperature -30°C to +95°C. Operate time 10 ms. The little gem is an 0.8 oz. 7/8" cube.

Quality features include: double-break contacts; balanced armature, enclosed housing, plug-in application; encapsulated coil; self-wiping contacts and inherent snap-action—and the cost is lower than you think!

Write today for additional data, prices and samples.

Executone inc. COMPONENTS DIVISION
 47-37 Austell Place, Long Island City 1, N. Y.

CIRCLE 205 ON READER SERVICE CARD



**electronics
 IS EDITED
 TO KEEP YOU
 FULLY INFORMED**
 — a "well-rounded"
 engineer

What's your *present* job in electronics? Do you work on computers? (*electronics* ran 158 articles on computers between July, 1961 and June, 1962!) Are you in semi-conductors? (For the same period, *electronics* had 99 articles, not including transistors, solid-state physics, diodes, crystals, etc.) Are you in military electronics? (*electronics* had 179 articles, not including those on aircraft, missiles, radar, etc.)

In all, *electronics'* 28-man editorial staff provided more than 3,000 editorial pages to keep you abreast of all the technical developments in the industry. No matter where you work today or in which job function(s), *electronics* will keep you fully informed. Subscribe today via the Reader Service Card in this issue. Only 7½ cents a copy at the 3 year rate.

electronics

electronics • April 5, 1963

**NEW
 MINIATURE
 DELAY LINES**

¼ CU. INCH PER μSEC.



**Total delay of 20.3 μsec. in
 2 lines with 14 taps
 Overall size 4" x 4"**



- Total delay accuracy better than ½ of 1%
- Total delay to rise time ratio better than 30:1
- Distortion under 4%
- Temp. coefficients less than 50 ppm/°C

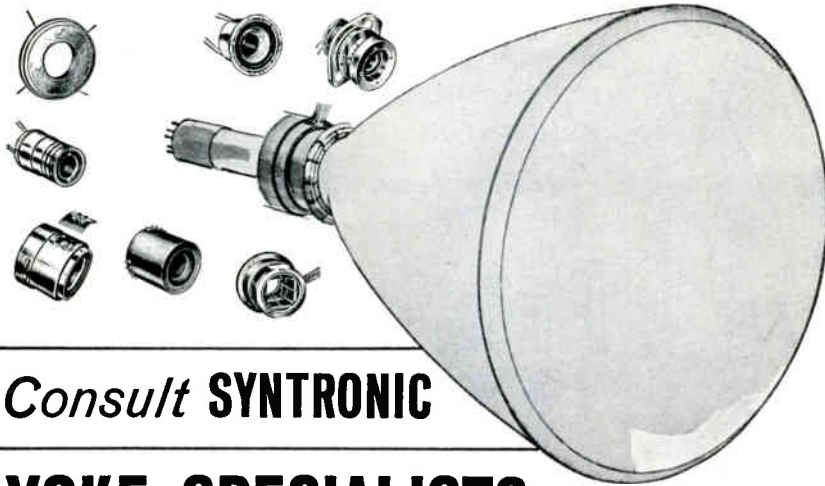
WRITE FOR DETAILS



Palo Alto Division of Admiral Corporation
 Stanford Industrial Park, Palo Alto, California

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WHICH DEFLECTION YOKE ? FOR YOUR DISPLAY



Consult **SYNTRONIC**

YOKE SPECIALISTS

Syntronic's team of experts knows more about yoke design, engineering and quality control than anyone else. A solid 10-year record of leadership—acknowledged throughout the industry. Benefit from it.

syntronic **INSTRUMENTS, INC.**
100 Industrial Road, Addison, Illinois
Phone: Kingswood 3-6444

CIRCLE 206 ON READER SERVICE CARD

HERE IS THE WORLD'S SMALLEST MOTOR YET IT'S SO POWERFUL . . .

MITSUMI MICRO MOTOR



MODEL MI-100

Less than 20mm in diameter, the new Mitsumi Micromotor provides a startling efficiency of over 50%, the barrier which miniature motors are not allowed to pass.

A novel construction principle helped to make this accomplishment possible. The form is more simplified by setting all the terminals at one position. Because the entire mechanism is given full protection against irregular revolution and above all, electrical noise is entirely eliminated, you may call this the most perfect micromotor yet devised. Please write for complete information on Mitsumi Micromotor, and we will send you specifications and data.



MITSUMI PARTS
MITSUMI ELECTRIC CO., LTD.
TOKYO • OSAKA • NEW YORK

over 10 years. For the past few years, he was a consulting engineer with GE.

Reeves Instrument Elects Pastorino

ELECTION of E. T. Pastorino as executive vice president of Reeves Instrument Corp., Garden City, N.Y., subsidiary of Dynamics Corp. of America, is announced.

Pastorino joined Reeves in 1956, and in July, 1962, was appointed vice president for contract administration.

PEOPLE IN BRIEF

David C. Steer promoted by Computer Sciences Corp. to head of its European offices. **Nicholas Frantzis**, formerly with Minneapolis Honeywell, elected exec v-p and appointed director of engineering for Semtran Instruments, Inc. **A. N. Bronson**, Pakco Companies, Inc., exec, appointed president of the recently acquired H. O. Boehme Co., Inc. **Charles W. Newhall, Jr.** moves up to v-p of The Marquardt Corp. Dow Corning Corp. advances three to v-p's: **R. William Caldwell**, director of engineering; **Howard N. Fenn**, director of manufacturing; and **Melvin J. Hunter**, director of research. Rocket Jet Engineering Corp. ups **John T. Soja** to v-p. **Arthur C. Davis** resigns the presidency of Sonotec Corp. to head up the new Electrical Research Products, Inc. **V. I. Robinson**, previously chief engineer, appointed director of engineering for Pacotronics, Inc. **Hugh E. Riordan** promoted to director of gyro dynamics research at General Precision's Kearfott div. **Stanley Cohen**, from chief engineer to v-p of engineering for Kollsman Motor Corp. **August F. Siemon**, Lt. Col., USAF Ret., has joined the Development div. of International Electric Corp. as senior system specialist. **Richard M. Hurst**, Brig. Gen., USA Ret., named v-p for planning at Textron's Bell Aerosystems Co. **Bertram A. Kramer**, ex-Fairchild Camera and Instrument Corp., appointed chief engineer for the Instrument & Systems section, Engelhard Industries, Inc.

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 #
APPLIED PHYSICS LABORATORY The Johns Hopkins University Silver Spring, Maryland	78	1
ATOMIC PERSONNEL INC. Philadelphia, Penna.	78	2
HONEYWELL St. Petersburg, Fla.	68	3
INTERNATIONAL BUSINESS MACHINES CORP. Space Guidance Center Owego, New York	72*	4
ITT-INTELCOM, INC. Bailey Crossroads, Va.	72*	5
LOCKHEED MISSILES & SPACE COMPANY Div. of Lockheed Aircraft Corp. Sunnyvale, California	73	6
P 1823	78	7

* These advertisements appeared in the March 29th 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

CITYZONE.....STATE.....

HOME TELEPHONE

Education

PROFESSIONAL DEGREE(S)

MAJOR(S)

UNIVERSITY

DATE(S)

FIELDS OF EXPERIENCE (Please Check)

4563

- | | | |
|--|--|---------------------------------------|
| <input type="checkbox"/> Aerospace | <input type="checkbox"/> Fire Control | <input type="checkbox"/> Radar |
| <input type="checkbox"/> Antennas | <input type="checkbox"/> Human Factors | <input type="checkbox"/> Radio-TV |
| <input type="checkbox"/> ASW | <input type="checkbox"/> Infrared | <input type="checkbox"/> Simulators |
| <input type="checkbox"/> Circuits | <input type="checkbox"/> Instrumentation | <input type="checkbox"/> Solid State |
| <input type="checkbox"/> Communications | <input type="checkbox"/> Medicine | <input type="checkbox"/> Telemetry |
| <input type="checkbox"/> Components | <input type="checkbox"/> Microwave | <input type="checkbox"/> Transformers |
| <input type="checkbox"/> Computers | <input type="checkbox"/> Navigation | <input type="checkbox"/> Other |
| <input type="checkbox"/> ECM | <input type="checkbox"/> Operations Research | <input type="checkbox"/> |
| <input type="checkbox"/> Electron Tubes | <input type="checkbox"/> Optics | <input type="checkbox"/> |
| <input type="checkbox"/> Engineering Writing | <input type="checkbox"/> Packaging | <input type="checkbox"/> |

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

ELECTRONIC ENGINEERS FOR SATELLITE DESIGN PROJECTS

TRANSIT • TRAAC • ANNA

Several Engineers are urgently needed to assist in designing memory systems for APL-developed TRANSIT, TRAAC and ANNA satellites. These are coincident current memories containing some 25,000 ferrite cores and 200 transistors driven by 1½ watts. Counting, scaling, satellite control and other functions as well as protective (fail-safe) circuits are integrated with the memories. Solutions will require many new and novel concepts.

Accepted applicants will be primarily concerned with magnetic logic and circuitry. They will collaborate closely with packaging designers to assure survival in severe launch and orbital environments. Simplified circuits, fewer components and easier fabrication leading to long life are major objectives. The positions require BS or MSEE degrees and a minimum of three years' experience in transistor circuit design for digital equipment.

A second assignment involves design, assembly and test of a small computer for shipboard doppler navigation. This is a low-speed serial device employing new and unique concepts of program control. Appointment to this group will afford an opportunity to learn magnetic design if desired. Respondents should have a BS or MS degree in EE or Physics, elementary understanding of computer logic, and experience in transistor design.

APL's modern and well equipped facilities are located an equal distance between Washington, D. C. and Baltimore, giving you a choice of country, suburban, or city living. Several nearby universities offer graduate study. Public schools in the area rate among the best in the nation.

Direct your inquiry to:
Professional Staff Appointments

The Applied Physics Laboratory • The Johns Hopkins University

8633 Georgia Avenue, Silver Spring, Maryland
(A residential suburb of Washington, D.C.)

An equal opportunity employer

EMPLOYMENT OPPORTUNITIES



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

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

— RATES —

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

An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

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

Box numbers—count as 1 line.

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

Not subject to Agency Commission.

ELECTRONIC ENGINEERS

- CAREER OPPORTUNITY
- CHALLENGING ASSIGNMENT
- TOP EARNINGS

Leading, independent research organization has a position available for a man with a BS or MS degree in Electronic Engineering. A man with experience in the development of vacuum tubes, transistor or relay circuits, or a recent outstanding college graduate will qualify. Interesting, unusual work in data transmission and retrieval and digital computing.

- NON-MILITARY WORK
- INDIVIDUAL EFFORT RECOGNIZED
- GOOD JOB SECURITY
- IDEAL WORKING CONDITIONS
- EXCELLENT EMPLOYEE BENEFIT PROGRAM
- LONG ESTABLISHED FIRM
- SPONSORED GRADUATE STUDY PROGRAM

Comfortable living in Chicago Suburban areas only minutes away.

FORWARD YOUR RESUME IN CONFIDENCE

P-1823, Electronics
645 N. Michigan Ave., Chicago 11, Ill.

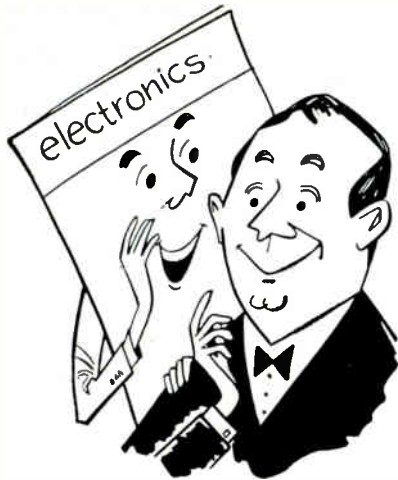


E. E.'s

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.



electronics IS EDITED TO KEEP YOU FULLY INFORMED

— a “well-rounded” engineer

What's your *present* job in electronics? Do you work on computers? (*electronics* ran 158 articles on computers between July, 1961 and June, 1962!) Are you in semiconductors? (For the same period, *electronics* had 99 articles, not including transistors, solid-state physics, diodes, crystals, etc.) Are you in military electronics? (*electronics* had 179 articles, not including those on aircraft, missiles, radar, etc.)

In all, *electronics*' 28-man editorial staff provided more than 3,000 editorial pages to keep you abreast of all the technical developments in the industry. No matter where you work today or in which job function(s), *electronics* will keep you fully informed. Subscribe today via the Reader Service Card in this issue. Only 7½ cents a copy at the 3 year rate.

electronics

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is \$27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ¾ inch vertically on one column, ¾ columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

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

PROPOSALS, \$2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

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

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR. 584 AUTO-TRACK RADARS
AN/APS-10 SEARCH, AN/APS-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
5-12 MEGAWATT HIGH POWER PULSERS.

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

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 950 ON READER SERVICE CARD

SPECIAL SERVICES

Technical Writing And Editing—Save time and energy; let us finish the rough draft of your article or book. Write for details. The Literary Forge, Port Republic, N. J.

LOOKING FOR

USED/SURPLUS ELECTRONIC
EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of March 8th issue.

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GIBBS & HILL, Inc.

Consulting Engineers

Systems Engineering

Operations Research • Development

Field Studies • Design • Procurement

Power • Transportation • Communications

Water Supply • Waste Treatment

393 Seventh Avenue

New York 1, N. Y.

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electronics



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of Circulation



Associated Business
Publications

Audited Paid Circulation

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Advertising Sales Manager

BEN ANELLO

Market Services Manager

DAVID CUNNIFF

Promotion Manager

■
Electronics Buyers' Guide

R. S. QUINT
General Manager

■
RICHARD J. TOMLINSON
Business Manager

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(area code 404)

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McGraw-Hill Building, Copley Square,
Congress 2-1160 (area code 617)

CHICAGO (11):

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

CLEVELAND (13):

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

DALLAS (1):

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

DENVER (2):

John W. Patten
Tower Bldg., 1700 Broadway,
Alpine 5-2981 (area code 303)

HOUSTON (25):

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

LOS ANGELES (17):

Ashley P. Hartman, John G. Zisch,
William C. Gries
1125 W. 6th St., Huntley 2-5450
(area code 213)

NEW YORK (36):

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

PHILADELPHIA (3):

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

SAN FRANCISCO (11):

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255 California Street, Douglas 2-4600
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GENEVA:

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TOKYO:

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

which of these

13

KIN TEL instruments
does your standards
lab need?

Used in leading standards labs
throughout the country, they may
supply the exact degree of accuracy,
stability, range, and versatility
your applications demand.

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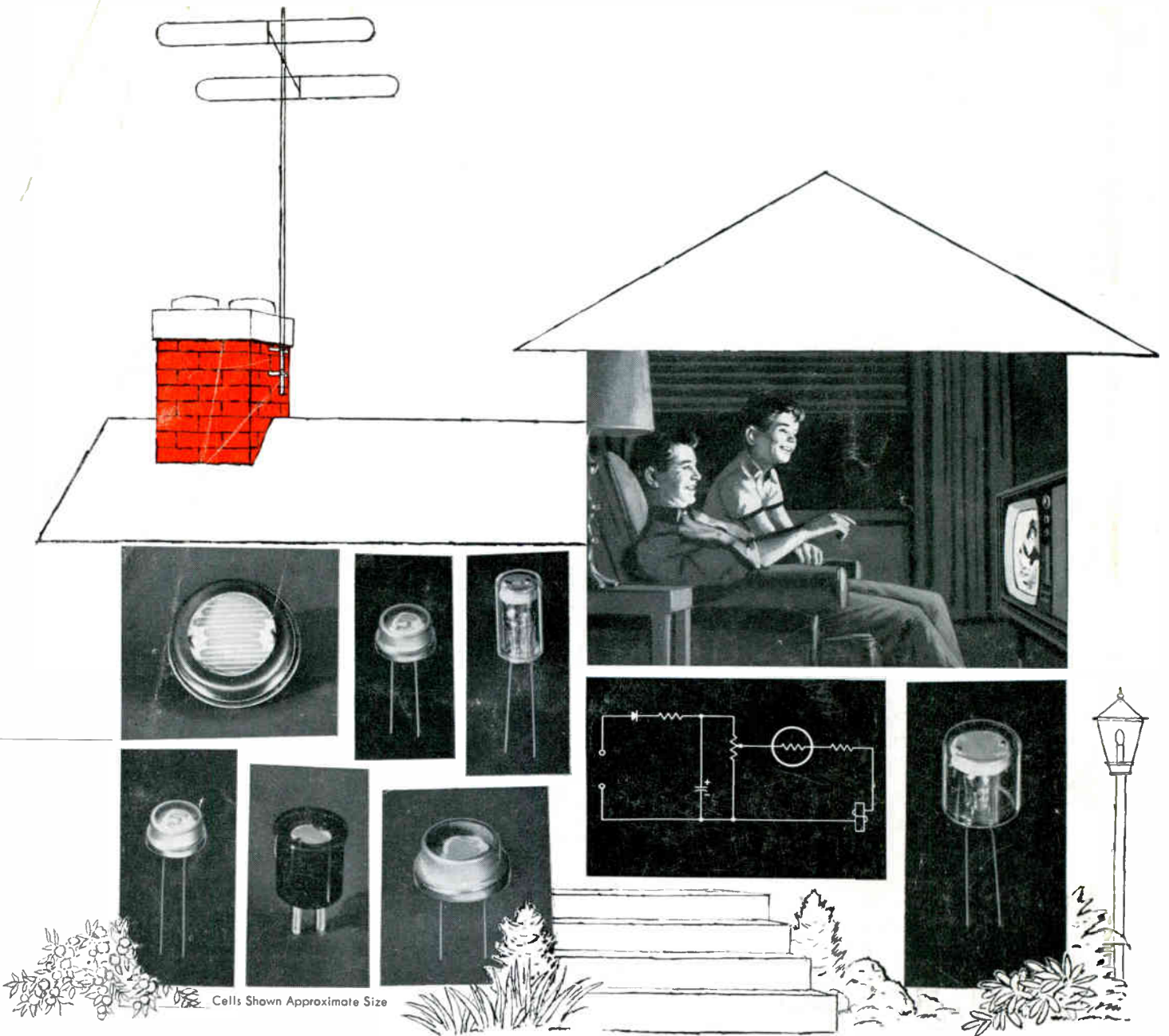
- 5. AC/DC Digital Voltmeter (Model 502B).** Gives you DC accuracy within 0.01% of reading; over-ranging on both AC and DC; automatic ranging and remote (programmable) control. Measures DC between ± 100 microvolts and ± 1000 volts, AC from 30 cps to 10 kc between 1 millivolt and 1000 volts. Four-digit readout. Price: \$4245. Available as a DC digital voltmeter only (Model 501B). Price: \$2995. Either of above models available with Zener diode reference source.
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RCA Type	Volts DC or Peak AC	Power Dissipation - Watts		Photo-current (ma)	Volts	Illumination Foot Candles	Photocurrent (ma)	
		Contin-uous	Demand*				Min.	Max
4403	250	0.3	0.75	50	50	1	7	16
4404	600	0.3	0.75	50	50	1	2.5	5
4448	600	0.3	0.75	50	50	1	1.5	4
4453	600	0.3	0.75	50	50	1	3	7
7163	600	0.3	0.75	50	50	1	1	3
4423	250	0.2	—	20	50	1	1.5	4
4424	110	0.2	—	50	12	1	3.6	14.5
4425	110	0.2	—	50	12	1	3.6	14.5
SD2500	250	0.2	—	20	12	1	0.24	0.80
4402	200	0.05	—	5	12	10	1.6	—
4413	110	0.05	—	5	12	10	1.0	2.75
7412	200	0.05	—	1	12	1	0.065	0.275
7536	200	0.05	—	1	12	1	0.065	0.275
6694A	150	0.03	—	—	90	30	0.057	0.65

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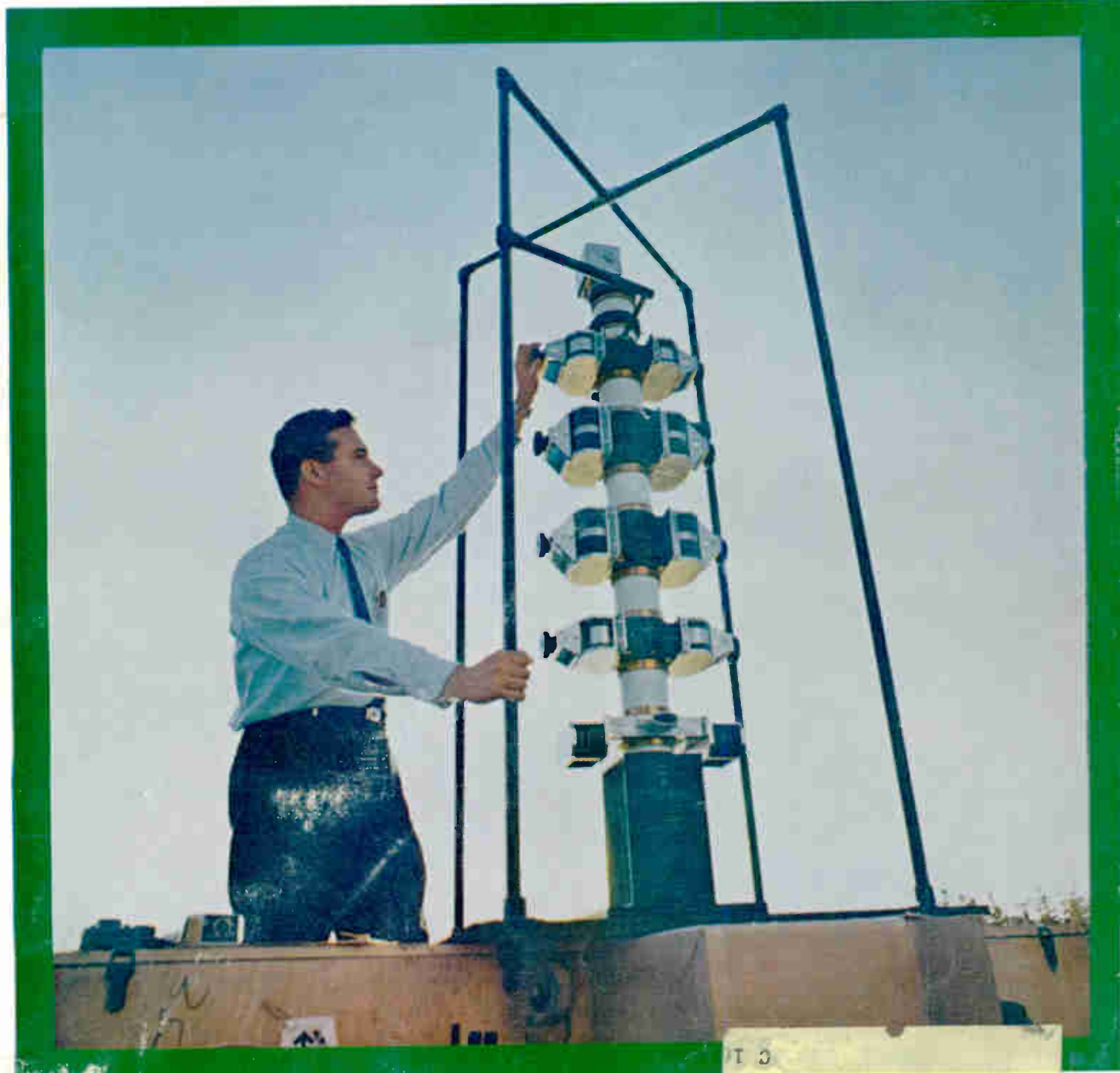
electronics

NEW STANDARD FOR COLOR TV?

Europe investigates German system, p 22

MICROELECTRONICS AROUND THE WORLD

Japanese and Europeans are emphasizing early use in commercial equipment, p 37



NEW POWER KLYSTRON tube is ready for all-channel tv switchover, p 61

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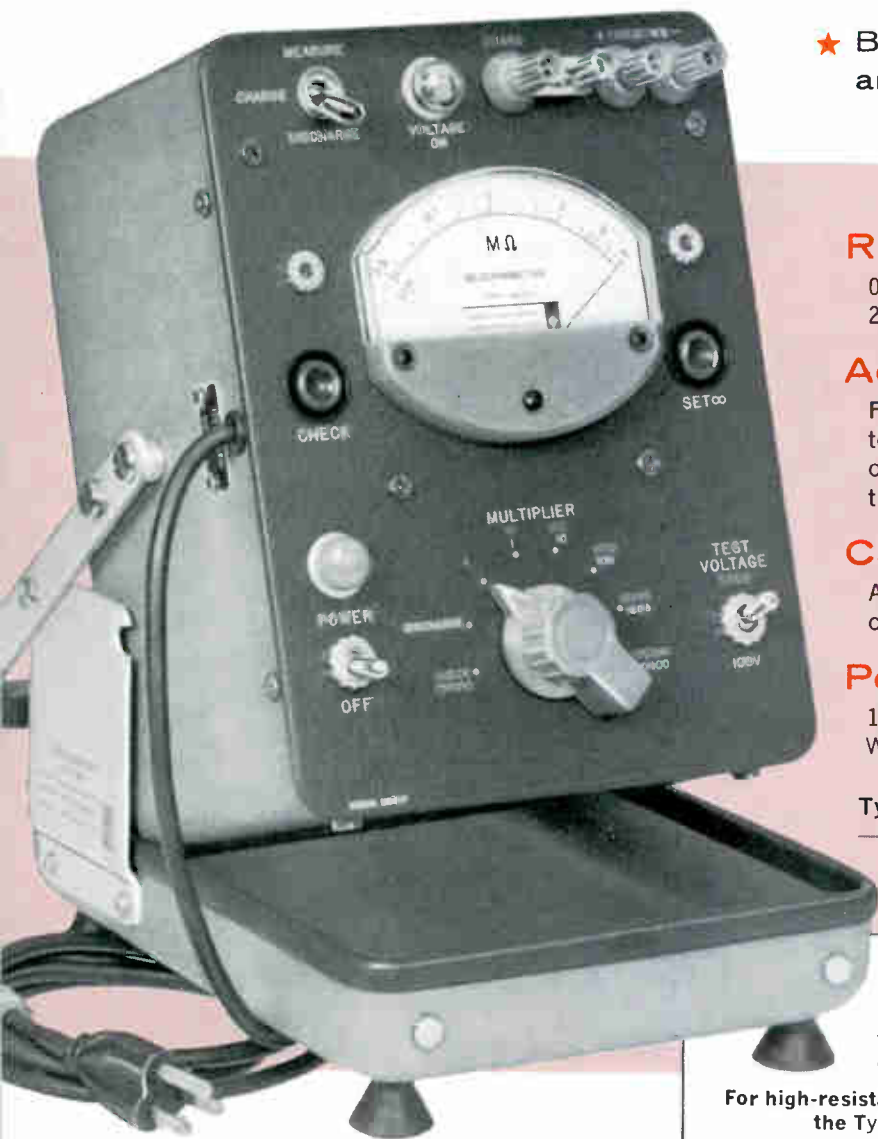
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Accuracy:

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AIR-COOLED power klystron by Amperex mounts directly on a uhf-tv transmitter tower. This arrangement solves coupling problems from transmitter to antenna. High-power gain of 30 db enables design engineer to simplify transmitter circuits. *The tube's 11-Kw output was designed for uhf television broadcasting and tropo scatter. See p 61* **COVER**

ATOMIC TEST BAN: What Does It Mean to the Electronics Industry? The atmospheric, oceanic and space test ban initialed in Moscow last week can have far-reaching consequences for the industry if its proclaimed aim of disarmament acquires any meaning. *But for now, government and industry officials see slight impact on weapons systems and defense sales* **18**

EUROPE'S COLOR-TV Competition Gets a New Entry from West Germany. Phase alternation line system claims freedom from path distortion and other advantages over the SECAM and NTSC system. *BBC will test the new system soon* **22**

ILS ANTENNA Driven by Tuning Fork. All-weather landing system uses torsion bars for scanning. *Developers say it cuts the number of data channels from three to one* **24**

FRENCH CODE Gains in Europe. CMC 7 magnetic character reading system applications are snowballing. *One major attraction is that only a single head is needed to read the printing on checks and other documents* **28**

FLYING RELAY for Television. Helicopter system transmits remote pickups to ground base. *Slaving airborne and ground antennas helps raise range to 80 kilometers* **32**

MICROELECTRONICS AROUND THE WORLD. Heavy emphasis on applying microcircuits to industrial automation is reported from abroad. In fact, the first large-scale appearance of microelectronics on the commercial scene may come first in Europe and Japan, according to on-the-scene reports from six nations. Even some consumer products are under development. *This could mean a breakthrough in prices within the next few years* **37**

SEQUENCE PULSE GENERATOR Conserves Transistors. Control systems often require a multiplicity of independent sequential timing and gating pulses. This circuit can develop as many as 10 output pulses from a single input, for programming and complex wave shaping. *Accuracy and stability are identical with individual pulse formers.*

By A. S. Ottenstein and R. L. Paul, Seaboard Electronic **44**

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LOW NOISE INPUT CIRCUITS: How to Design Them. Circuit designers must attack the amplifier noise problem from three fronts—internal noise, source noise and noise bandwidth. This analysis shows how to get the lowest possible noise by component selection and impedance level adjustment. *Field effect transistors excel at high source impedance levels.*
By J. J. Rado, Precision Instrument Co. 46

DELTA-MODULATED TV For Long Distance Transmission. When transmitting a high-quality television signal over waveguide, where the distance between repeaters is 25 Km or more, distortion due to dispersion of the signal may result. *This tunnel-diode circuit permits 100-Mc clock rates, eliminates distortion and lowers quantizing noise.*
By C. Kramer and J. C. Balder, Philips Research Laboratories 50

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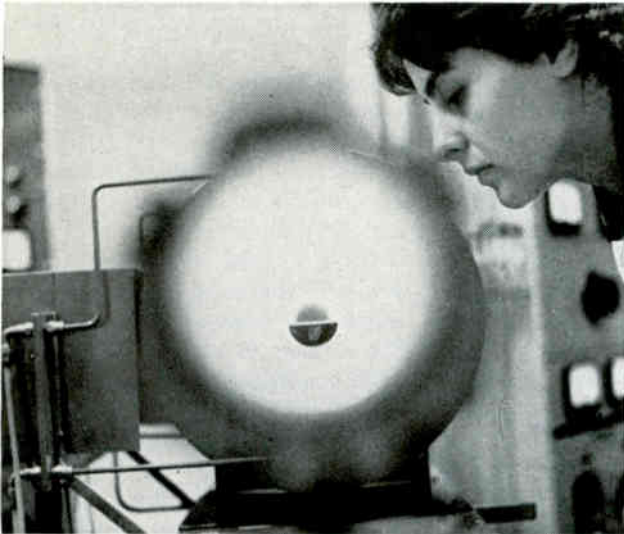
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Microelectronics Abroad



SILICON diffusion and oxidation furnace at Italian plant of *Societa Generale Semiconduttori*

THIS WEEK'S report of microelectronics activities in six distant countries (p 37) is an eye-opener. It should prove especially interesting to those U.S. electronics firms who feel microelectronics is still "blue sky" and are waiting for developments to settle down before they offer such equipment for sale.

Manufacturers in Western Europe and in Japan appear to be pushing microcircuits for commercial, industrial and consumer equipment harder than we are. American suppliers of microcircuits are already aware of the high overseas interest and are, in fact, capitalizing on it through foreign affiliates. It is largely the U.S. end-equipment manufacturer who has not yet clearly heard the message.

As we reported three months ago (p 22, May 10), U.S. manufacturers of civilian electronics products do not seem to be in any hurry to use microcircuits or to push their large-scale application in major equipments. Europeans apparently are not so hesitant. Their economic need for automated industrial controls, for example, is forcing them to push ahead and some prototypes are already in the works. The Japanese are using more microcircuits in computers and other industrial electronics products. Signifi-

cantly, they are also planning microcircuit consumer products.

We have seen enough microelectronics to recognize that it constitutes a coming wave of progress. The U.S. right now leads the world in microcircuit development. The military, who have underwritten much of the R&D cost and most of the initial production, and component developers and suppliers, have done their part. But we can lose our lead if we do not more rapidly put microcircuits to work.

WINTER SET. Two weeks ago, Assistant Editor Strasser walked into Canada's Defense Research Northern Laboratory—aptly named since it is located at Fort Churchill, on Hudson's Bay, 500 miles south of the Arctic Circle—and there on the magazine rack was the current issue of *ELECTRONICS*.

That's nice, thought Strasser. But he really felt at home when the librarian took him in tow and showed him a bound collection of *ELECTRONICS* dating back to 1930, the year we were founded. The 33-year set is part of a reference collection used by technical personnel in the far north.

You might expect the library to be used most during the winter, when the sun goes down for six months, temperatures drop to 70 below and the snow reaches the rooftops. But there is little or no night-life in the summer, either—the sun never sets, the frozen wastes turn into swamps and there are deer flies 1½ inches long. Strasser got the bites to prove it, though his hosts passed out insect repellent.

Strasser was one of several editors and reporters selected to fly aboard former President Eisenhower's plane, *Columbine III*, to Fort Churchill to witness the NASA and Air Force sounding rocket firings during the solar eclipse (*ELECTRONICS*, p 8 and p 37, July 26).

GONE WEST. Our well-traveled associate Larry Shergalis, once labelled "farthest-flung" editor in these columns, is now Regional Editor, Pacific Coast, based in San Francisco. That's being flung pretty far.

Larry drove his family across continent last month, following the tracks of the wagon trains and sometimes in them. His only mishap was an electrical failure, something the pioneers did not worry about.

Larry will cover the important electronics activities in the Bay area and the Pacific Northwest.

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COMMENT

Hi Fi

I was both surprised and disturbed when I read the article, How Hi is Fi? (p 33, June 14), by Senior Associate Editor Wolff and Dr. Goldmark.

I have always looked upon the recording and reproduction of sound as a science rather than an art. The job of the recording and reproducing equipment is to record sound as faithfully as possible as it is received at the microphones. The reproducing apparatus must then reproduce the original at the speaker. If the recording director wishes to place the listener in the audience, he places the microphones there. The long-haired enthusiast may then wear earphones for an exact reproduction, and those of us who don't mind a bit of home flavor listen to speakers and tolerate the added effect of the reproducing room acoustics.

Dr. Goldmark places the listener in the position of a do-it-yourself chef who is provided a partial recipe and is expected to mix a special dish which, when sampled, cannot be distinguished from the real thing.

Let's have some live recordings made by placing microphones in the listener position during a live concert. It's just possible that if you start out with a genuine product, it can be preserved in recording and reproduced somewhere near the original without requiring special talents for gimmicks and gadgets on the part of the listener.

CURTIS W. FRITZE
St. Paul, Minnesota

Goldmark's Reply

The purpose of a good sound system in the home should be to create the same effect on the listener as intended by the composer. Proper microphone placement in the auditorium is important, of course, but insufficient to give maximum realism in the home where the listener's ears are usually exposed to a pair of loudspeakers placed at relatively close distance. To obtain an illusion of realism, the effect of space found in the concert hall has

to be simulated in the home as well. This was the purpose of my statements made during the interview referred to.

PETER C. GOLDMARK
CBS Laboratories
Stamford, Conn.

Tunnel Diode Errata

We request that an errata be published for the third article in the Gottlieb-Giorgis series on tunnel diodes (June 28, 1963, p 60), as follows:

On p 61, the first sentence of the last paragraph is inaccurate; it should read: "Converter Design—to start the autodyne converter design, one is given the operating r-f and i-f frequencies."

On p 62, the next to last paragraph in the third column, one half sentence is missing. It should read: "It is best to start from the low gain conditions and work towards increased gain to avoid frustrations caused by circuit instabilities."

On p 63, in the first column, a half sentence is omitted in the second paragraph's second sentence. It should read: "In the range of 100 to 135 mv bias, the gain is less than unity, but since the sensitivity of car radios is generally high, this conversion loss is of little consequence."

In the editorial box of p 64, the last two sentences should be: "Owing to their lower peak currents, back diodes would have much smaller junction areas and could be more fragile than tunnel diodes. Therefore, lower-current-concentration material is generally used to make back diode junctions larger and hence mechanically strong."

On p 65 in the first column, a portion of a sentence in the middle of the second paragraph has been deleted, obscuring the meaning. The sentence should read: "The relative merits of a tunnel diode converter versus a tunnel diode amplifier followed by a standard converter require investigation."

On p 66, in the fourth paragraph, the item between parentheses should read "(30 Mc i-f)".

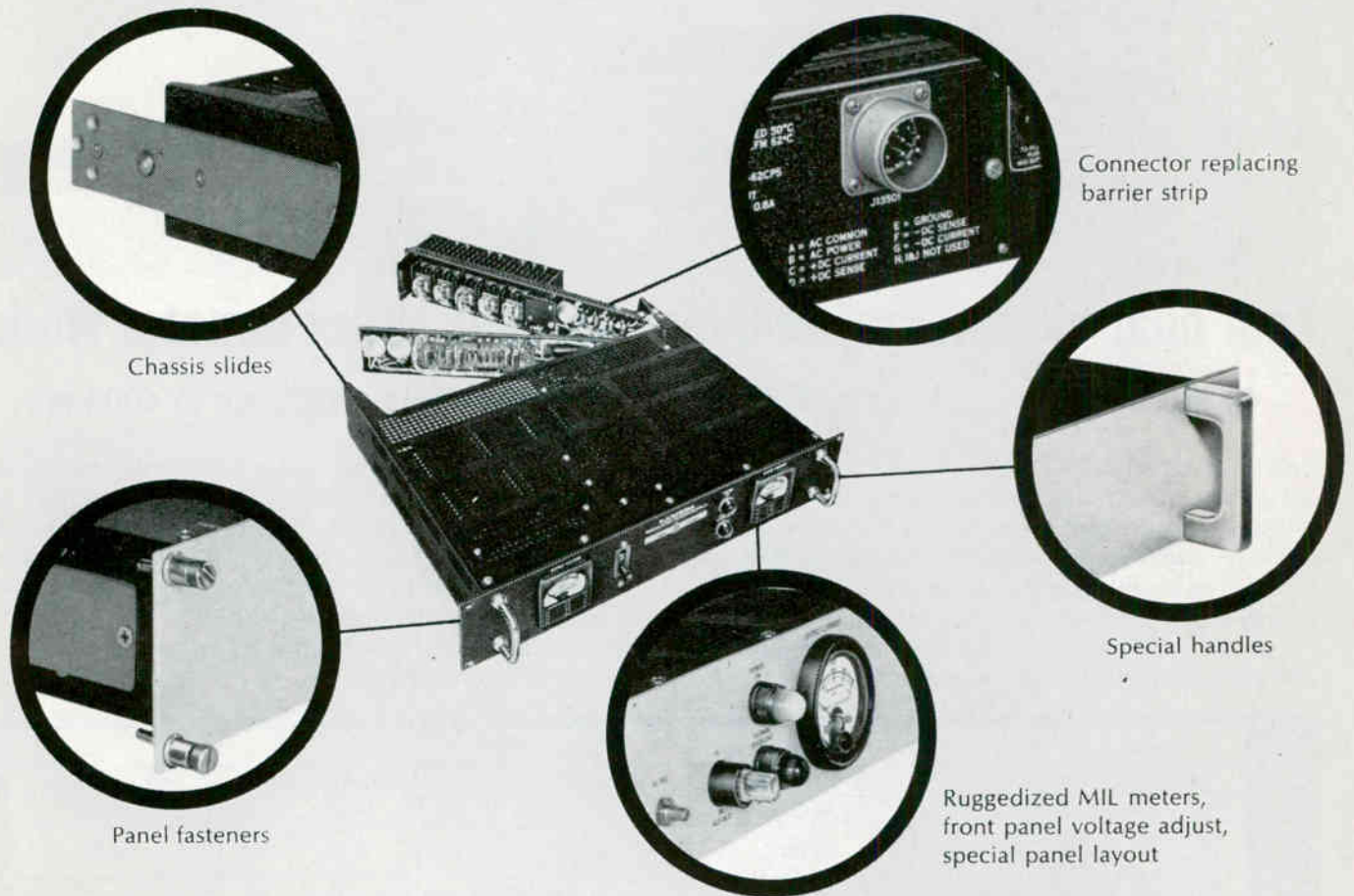
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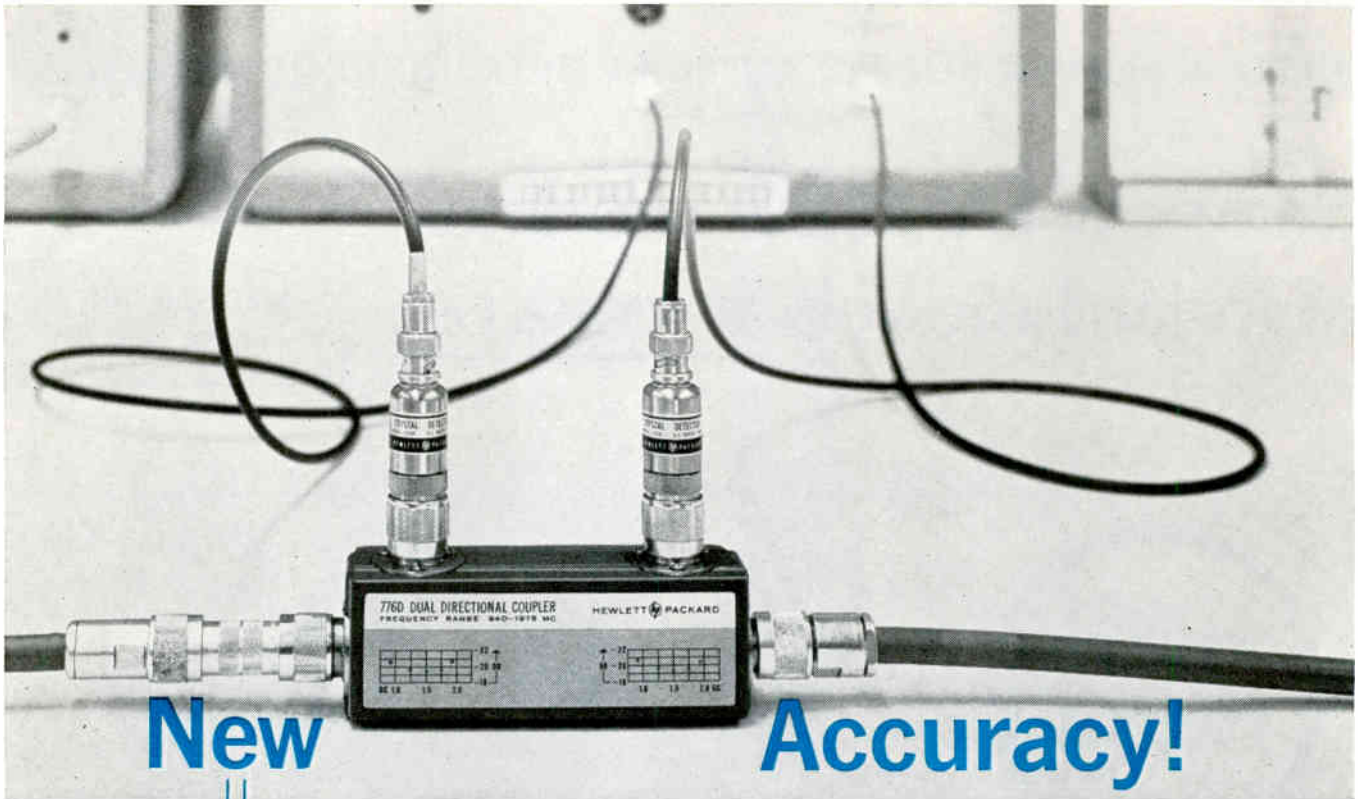
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SPECIFICATIONS	Model	774D	775D	776D	777D
	Frequency range:	215 to 450 mc	450 to 940 mc	940 to 1900 mc	1900 to 4000 mc
	Minimum directivity:	40 db	40 db	40 db	30 db
	Coupling attenuation: (each secondary arm)	20 db	20 db	20 db	20 db
	Accuracy of coupling: (each secondary arm)	Mean coupling level within 0.5 db of specified values			
	Coupling variation:	Less than ± 1 db over frequency ranges			
	Max. primary line swr: (50-ohm terminations)	1.15	1.15	1.15	1.25
	Max. secondary line swr: (50-ohm terminations)	1.20	1.20	1.20	1.50
	Power handling capacity:	50 watts cw 10 kw peak	50 watts cw 10 kw peak	50 watts cw 10 kw peak	50 watts cw 10 kw peak
	Primary line insertion loss:	Approx. 0.15 db	Approx. 0.20 db	Approx. 0.25 db	Approx. 0.35 db
Price:	\$200	\$200	\$200	\$200	

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



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Japan Firms Setting Minimum Tv Prices

TOKYO—Seventeen of Japan's major tv manufacturers are nearing agreement on minimum prices to charge exporters for tv sets destined for the U. S. market. The actual export prices cannot be set because of Japan's antitrust laws.

The minimum prices will apply to four classifications of sets: 19-inch, 16-inch, 5 and 6-inch and smaller than 5-inch sets. Exempt are color and closed-circuit sets.

The agreement covers the bulk of tv production by EIA-J members and is being made "to maintain orderly marketing." If everything proceeds smoothly, it should be ratified and in effect by October, EIA-J says. Similar agreements now cover dry cells and binoculars.

Topsy-Turvy Processing Reduces Diode Leakage

UPSIDE-DOWN processing can cut reverse leakage current of diodes 1,000 times, while boosting forward current 100 times, according to Yuan Feng Chang and H. W. Thompson, Jr., of Purdue University. Superiority of the resulting abrupt junction strongly suggests that most alloyed junctions should be made with impurity balls on the high temperature side of semiconductor wafers.

Substitution of thick base contacts for ohmic or soldered contacts can also reduce reverse leakage currents of $p+nn$ and $p+pn$ diodes almost two orders of magnitude, Thompson reported, making thick base contact germanium diodes comparable to silicon diodes. Thick base contact diodes also deliver greater forward conduction at high current densities, he said.

Abrupt junctions were developed by placing antimony balls under p -type germanium wafers, and then controlling the temperature gradient to prevent diffusion. The "first truly abrupt junction" in silicon,

using n -type silicon wafers over aluminum balls, exhibited one single slope for six decades of current.

Strike Command Testing Systems Coordination

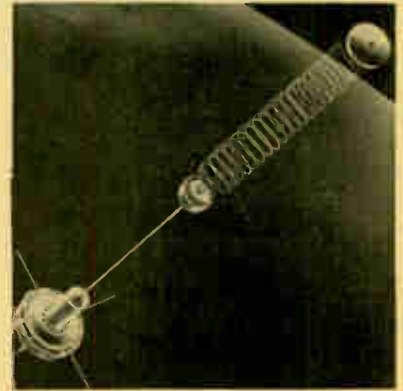
U.S. STRIKE COMMAND is finishing up the second week of a four-week joint exercise in a 7,500-square-mile area in the Carolinas and Georgia. More than 75,000 soldiers and airmen are participating in diversified air and ground operations.

One result of the "battle" will be more clearly defined requirements for making Army and Air Force electronic systems more compatible, and coordinating command and control equipment and procedures. Big contracts will eventually be awarded to make the USSTRICOM team a smoothly-operating force.

Telstar II: It's Either Power Supply or Antenna

MURRAY HILL, N. J.—Bell Telephone Laboratories engineers have narrowed down the reasons for Telstar II's failure to either a faulty power supply regulator or loss of the vhf helical antenna, according to Robert H. Shennum, head of BTL's satellite design department.

Satellite Stabilizer



GRAVITATIONAL stabilization system developed by Johns Hopkins' Applied Physics Laboratory is successfully keeping a new Navy satellite oriented toward the earth. System did not work properly when first used aboard the Traac satellite in November, 1961

BTL has tried all the trick commands used with Telstar I to bypass various single elements of the decoder circuit. None of these has worked, strongly suggesting that the decoder is not involved. On Telstar II, the 136-Mc beacon would stay on even if the command structure didn't function.

Visual sightings made with a telescope at Holmdel, N. J. on July 23 and 24 proved that the satellite's spin rate, orbit and axis have not changed.

BTL has 20 to 30 men working full time on Telstar II experiments.

The Cold War, Tv-Wise

CHICAGO—A late-model Russian tv set displayed here last week is hardly a threat to U.S. manufacturers. Here are a few of the reasons: a 17-inch picture tube 23½-inches long—twice the length of the U.S. counterpart; a weight of 65 pounds—14 pounds heavier than U.S. models, and brightness levels 30 percent below U.S. sets. The Russian set, shown in the Westinghouse booth at the National Association of Music Merchants convention, was reminiscent of the U.S. state of the art 10 years ago. It would cost a Russian worker 324 rubles (\$359.65)

Two more flyable Telstars exist, and although no decision has yet been made, launching of a third Telstar has not been ruled out.

Mueller Succeeds Holmes of NASA

NASA HAS named George E. Mueller to head the manned spaceflight program, succeeding D. Brainerd Holmes, who has resigned (p 22, June 21). Mueller, vice president for research and development at Space Technology Laboratories, will assume his new duties Sept. 1. Previously, Mueller had been engaged in the Atlas, Titan, Minuteman, Thor, Pioneer, and Explorer programs.

8-mm Maser Will Update Radiometer System

BEDFORD, MASS.—One of the first 8-mm masers ever built is expected to be delivered here within the next two months by RCA for a new radiometer system under development by the Air Force Cambridge Research Laboratories. The existing station atop Prospect Hill in Waltham, Mass., will be updated for radio and radar astronomy studies at 15-17 Gc and 35 Gc (8 mm).

New equipment will also include a computer-controlled precision antenna system.

Syncom II A Success, Drifting to Rendezvous

WASHINGTON—Syncom II is functioning well, according to reports early this week. It is drifting 4.5 degrees westward and in two weeks should reach a previously selected position at 55 degrees west longitude over northern Brazil. Temperature of the spacecraft was 10 degrees cooler than normal, but officials said this would be corrected.

Operating at a 22,800-mile apogee and 22,110-mile perigee, the satellite successfully completed demonstrations with music and

voice communications, teletype and facsimile test patterns. During the week, experiments were planned between Lakehurst, N. J. and the USNS Kingsport in Lagos Harbor, Nigeria. The satellite should be visible to both the U. S. and Europe sometime today.

Uhf Ruling May Spur Localized Vhf Production

CHICAGO—The prospect for localized vhf-only tv-receiver production was seen by FCC Commissioner Robert E. Lee last week, following a National Association of Music Merchants clinic on all-channel broadcasting during NAMM's convention and show here. Vhf-only sets could enjoy a \$20 to \$30 price advantage in this highly competitive market, since the \$6 extra cost of the uhf tuner at the manufacturers level is accelerated by markups all along its route to the consumer.

Miniaturized 3-D Radar Is Air-Transportable

LIGHTWEIGHT three - dimensional radar that can be transported by helicopter and quickly put into operation in remote areas has been developed by Hughes. The radar provides long-range, simultaneous, 3-D data (range, height, and bearing) on airborne targets, can be set up by six men in 30 minutes and operates unmanned.

Lightness is achieved by miniaturized circuitry, an efficient transmitter, planar (billboard type) array antenna concepts and compact packaging techniques. The radar will use frequency scanning techniques previously developed by Hughes. It will be compatible with existing weapon systems and adaptable to many air defense and air traffic control functions.

Hughes said the radar's narrow pencil beam reduces ground clutter and provides low-altitude detection capabilities at long range, even in electronic countermeasure environments.

In Brief . . .

COSMAT CORP. will award the multiple-access system contract in early August. The six bidders are ITT, RCA and Bell Labs (for the medium altitude system); GT&E and Hughes (for the synchronous system) and Philco (for the time delay modulation).

ARCO is supplying the Air Force with one of the most powerful industrial x-ray machines ever built. The unit will be used to check solid-fuel elements—primarily Minutemen missiles—for voids or other imperfections.

MAGNAFLUX has introduced a microwave, corona, gamma-backscatter and eddy-current system for testing glass-epoxy missile motor cases.

ELECTRICAL ENGINEER ranks have grown faster than any other major engineering branch, a National Science Foundation study shows. There were 50,000 EE's in 1940, an estimated 220,000 this year and there probably will be 325,000 by the decade's end, NSF said.

AEROJET GENERAL has successfully fired the transtage of Titan III. The transtage is the last stage of the Titan III launch system.

CARL ZEISS has developed electronic instruments to check camera lenses automatically. The device may reduce camera costs, as well as increase lens quality.

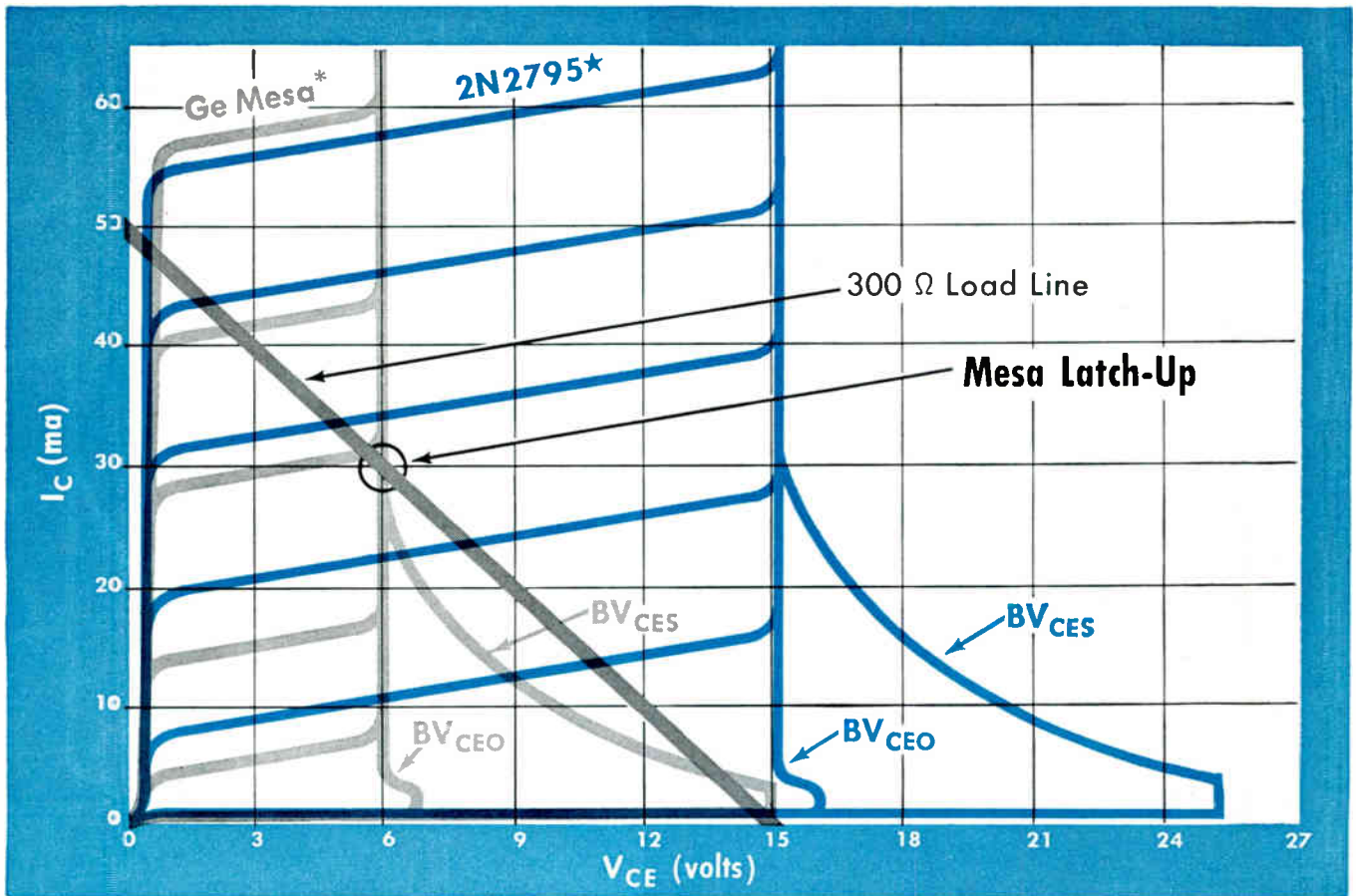
SANSEI, a Japanese firm, is establishing a plant in California to assemble radios.

CZECHIS have built their country's first gallium-arsenide diode laser.

LOCKHEED has installed a data-gathering system, based on two RCA 301 computers and 206 RCA EDGE (electronic data gathering equipment) units, that provides management with production line data from as far away as 400 miles.

SCIENTISTS at Sydney University in Australia have developed an electronic device that automatically keeps track of the egg-laying habits of a flock of hens.

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2N2796	450 mc	20 volts	12 volts
2N984	350 mc	15 volts	10 volts
2N979	150 mc	20 volts	15 volts
2N980	150 mc	20 volts	12 volts
2N2048†	250 mc	20 volts	15 volts

†(TO-9 Case)

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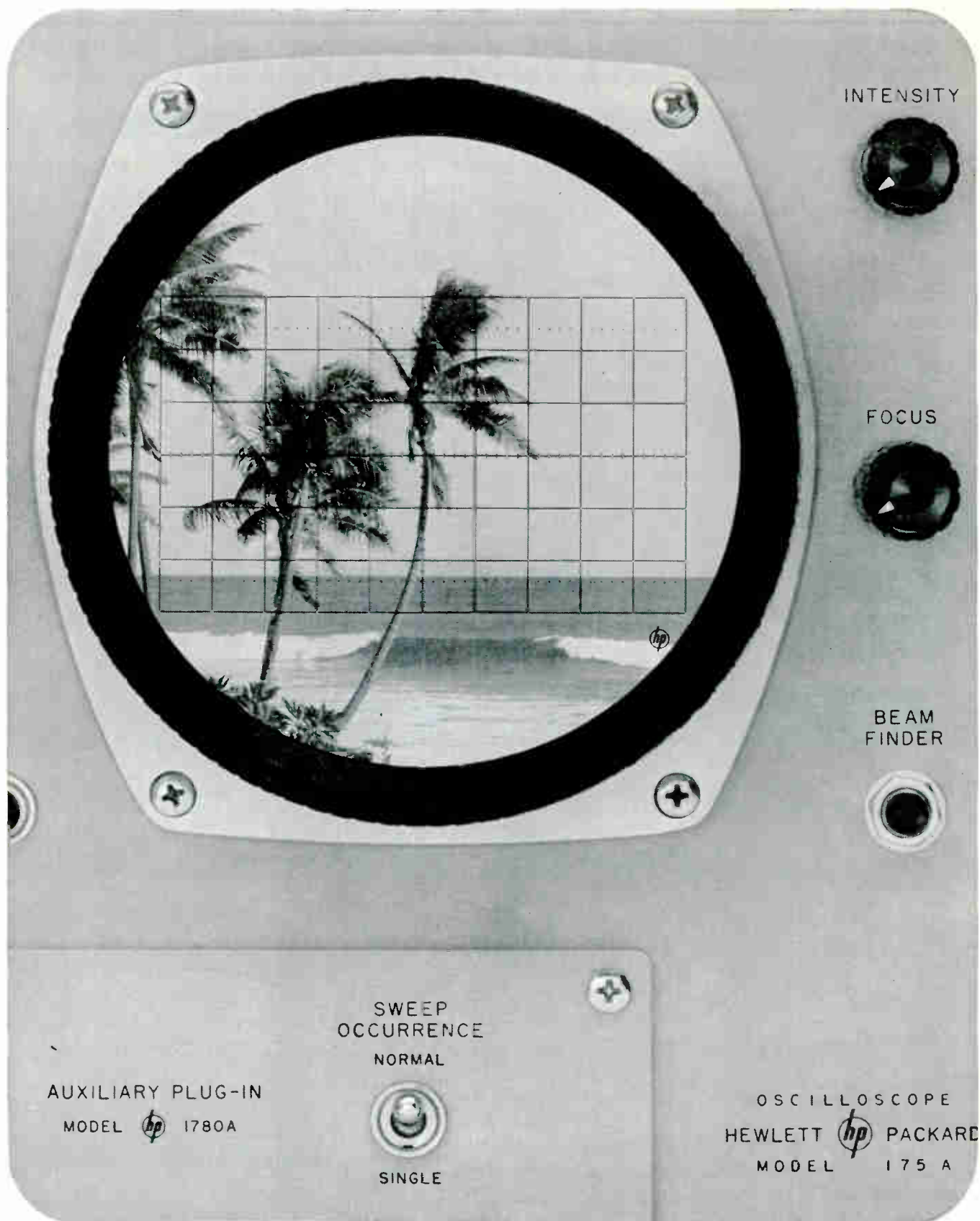
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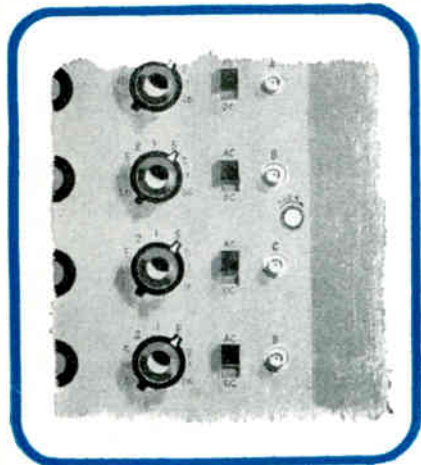
You can tailor the 175A to your exact measuring task with an inexpensive plug-in . . . one designed specifically for the 175A. Consider these plug-ins available for the 175A 50 MC Oscilloscope:

On the vertical side of the ledger, the 175A has about the same plug-in versatility as the scope you've been using . . . except that we can let you do more with fewer plug-ins and, consequently, at lower cost. Once you've got the basic scope—with its big 6x10 cm picture free from parallax error and glare, its easy operation and simple maintenance features—you can go where you want, measure what you want from there.

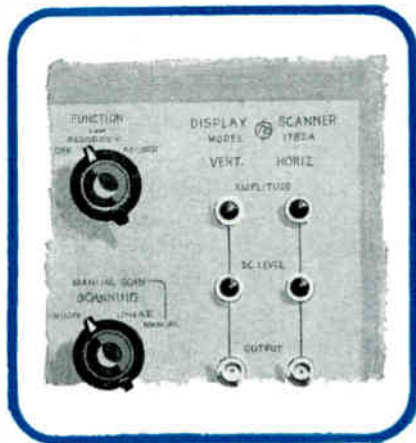
Our vertical plug-ins include these (and we invite comparison with plug-ins for your present high-frequency scope): A versatile dual trace vertical amplifier which provides sensitivity of 0.05 v/cm to 20 v/cm to 40 mc, \$285.



A single channel 50 mc amplifier which offers 50 mv/cm sensitivity, \$160. A high gain vertical amplifier which increases scope sensitivity to 5 mv/cm, \$225. A four channel vertical amplifier which permits big picture viewing of four traces at one time, to 40 mc, \$595.



Unique with our 175A is the fact that it accepts horizontal plug-ins, too—the only high-frequency scope of its type offering this extra versatility. Our sweep delay generator is a plug-in, and you can add it whenever you need the capability, \$375. Then there's the exclusive display scanner which permits making high-resolution x-y plots of traces appearing on the 175A crt, \$425. A time mark generator plug-in is useful for measuring rise time and pulse duration, and its markers are also useful for photography, \$130. The auxiliary horizontal plug-in allows the 175A scope to perform all its standard functions, \$25.



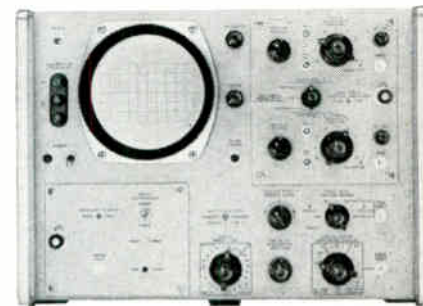
Because our 175A plug-ins are wide range and offer full sensitivity, you can do more . . . go farther . . . with fewer plug-ins. A money-saving item that lets you tailor your high frequency scope to meet your exact needs, adding plug-ins when, but not unless you need them.

Beyond this remarkable plug-in versatility, the 175A is a scope that'll introduce new accuracy through large-screen viewing and elimination of parallax error. It's also so easy to operate . . . color-coded controls so logically arranged that even a novice can learn to use it in half the time it takes to learn conventional scopes. The 175A has fewer controls, too. It offers positive pre-set syncing over the entire bandwidth, the easiest triggering and the most dependable triggering you can find in a high-frequency scope.



The maintenance story, too, is unprecedented. The sensitive 12 kv crt developed for the 175A permitted us to simplify driving circuitry . . . no distributed amplifiers, for example, with their attendant critical adjustment and alignment; and we've incorporated a new cable delay line that eliminates still more adjustments. We use only 7 tube types and 5 transistor types in the 175A . . . and none of them "selected." Think what that does to your parts inventory and how much it simplifies component replacement.

The 175A won't plan a trip for you, but it will get you where you want to go, measurement-wise, with a plug-in that's just the ticket. We're glad we don't have to charge you for more scope than you need, capabilities you don't really care about. You can *choose* the capabilities you *do* care about.



You can prove all this to your own satisfaction by setting the 175A alongside your present high-frequency scope and checking it out point by point. If you have anything at all to do with scopes, you owe it to yourself to take a look at the 175A. Same as we owed the 175A to you. hp 175A, \$1325 (plug-ins optional at extra cost).

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WASHINGTON THIS WEEK

COMSAT WANTS SATELLITE IN ORBIT BY 1965

TARGET DATES for the Communications Satellite Corporation are: freeze on system design by mid-1964; fly prototype satellites by mid-1965 and have a full system in operation by 1967. The corporation's technical priorities are to develop a multiple-access system, improve traveling-wave tube efficiencies and perfect attitude stabilization.

Government agencies are sufficiently advanced in stabilization work, so the corporation doesn't plan to buy research in this field. The corporation's first satellite system will use solar power. To conserve power usage, better tube efficiencies are wanted. The corporation is asking 15 American and six foreign companies if they can improve the efficiency of traveling-wave tubes.

A controversy may be brewing between the corporation and FCC. As it approved a \$600,000 loan request, FCC blasted the corporation for dragging its feet in getting a public stock offering out. FCC contended the temporary board of directors is dealing in basic decisions for the satellite system that a permanent board should make. The corporation counters that such decisions are necessary to a meaningful stock offering and that FCC has no authority over the initial stock offering. Earlier, FCC proposed a rule that the corporation notify FCC in advance of any contract that would exceed \$2,500. The corporation is certain to seek a higher ceiling. September 10 is set for replies to the proposed procurement regulation.

NASA'S BOSTON CENTER FUNDS FACE THE AX

FATE of the space agency's proposed \$50-million Boston electronics center hangs in fine balance. NASA sought \$5 million from Congress this year to get the new center started. The House Committee on Science and Astronautics cut NASA's request back to \$3.9 million. The Senate Aeronautical and Space Sciences Committee tentatively voted, 6 to 5, to cut all funds for the project. The vote came in executive session, however, with four members absent and all votes subject to change. Final outcome could go either way, say congressional sources.

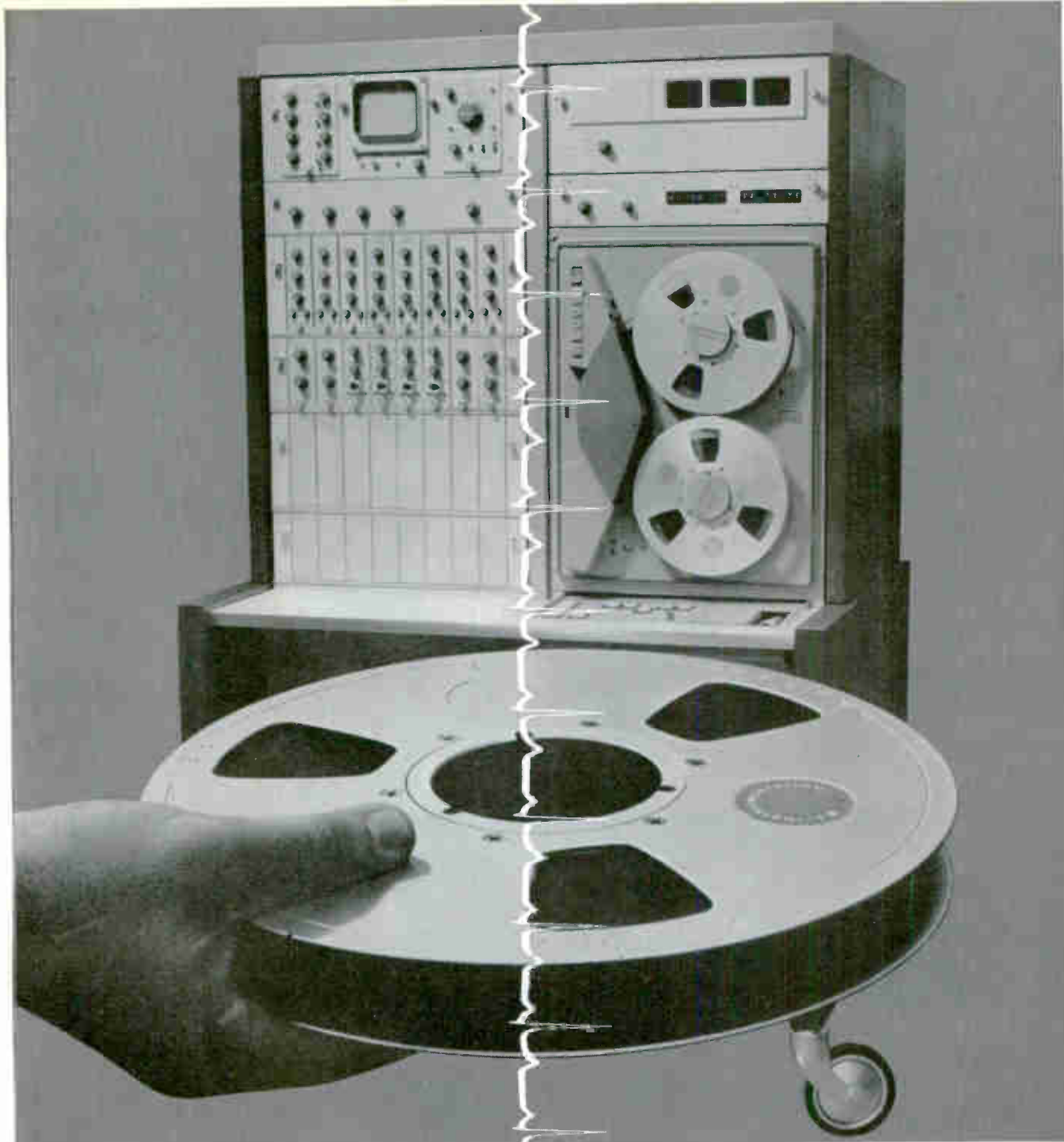
POLITICS AND TECHNICIANS

A POLITICAL VISE also holds the administration's proposed program to train more skilled technicians. The Vocational Education Act, with \$180 million in matching funds for state programs, has been halted at the House Rules Committee. Chariman Howard W. Smith (D-Va.) reportedly intends to hold it up there as an extra item for horse-trading on more controversial administration legislation.

POST OFFICE ACCELERATES AUTOMATION

POST OFFICE is pushing up by several years the anticipated readiness of reading machines for rounding out the postal mechanization program, (*ELECTRONICS*, p 26, July 12). As many as 30 companies are testifying to the reality of the new time estimate—field trails in two years—by competing for a contract containing that deadline. Award of a \$3-million to \$5-million research and development contract is expected by mid-August.

The devices will be limited to the recognition of five-digit numbers, used in the ZIP code program. If mass mailers number-code their mail, digit-readers and existing machinery can virtually remove the human touch from many mail-handling operations. Postmaster General Day says that three years after field tests, the readers should be in scores of major post offices.



What new data acquisition system provides data ready for processing? AMPEX DAS-100

Introducing: the new DAS-100 from Ampex. It's the first complete magnetic tape data acquisition system. And it's designed to permit easy editing, precision retrieving and rapid searching. So you can have your data ready for processing far sooner and have your answers far faster than ever before. The DAS-100 can accept data from transducers or electrodes, recording the events simultaneously with a continuous time code. It provides its own signal conditioning with a choice of preamplifiers depending on input. It locates



data rapidly and automatically to a resolution of one millisecond, feeds analog data to a graphic recorder and permits visual monitoring during and after the experiment. The system includes a 7- or 14-track FR-1300 recorder/reproducer, preamplifiers and their associated input couplers, a time code generator, an oscilloscope monitor, a level indicator and a master control panel for ease of operation. For more data about the new DAS-100 write Ampex Corporation, Redwood City, Calif. Worldwide sales, service.

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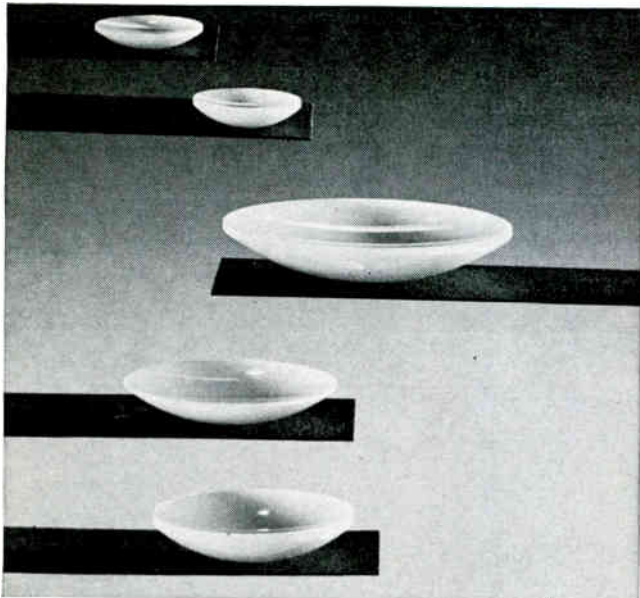
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*diameter of axial image of point source at which measured intensity drops to 5% of center peak intensity, for 2 - 4.5 μ range.

**net price each in 1-10 quantities, subject to change without notice.

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The experimenter acquires the purest AgNO₃ he believes in, reacts it with HCl, melts the AgCl powder, and from the melt grows crystals many centimeters in diameter. Nowadays he usually also zone-refines. If he chooses to place his faith in our *Specially Selected Silver Nitrate* (EASTMAN X-491, \$38 for 500 grams), he has our assertion that it contains less than 5 parts per billion of Hg and in parts per million, less than the following limits of spectrographic measurement: Cu, 0.1; Fe, 0.1; Pb, 0.3; Ni, 0.2; Sn, 0.1; Bi, 0.1; Pd, 3.0; Zn, 10.0; Cr, 0.2; Mn, 1.0; Cl⁻, 4.0; SO₄⁻, 6.0. The \$6.20 premium he pays over the price of 500 grams of plain *Silver Nitrate* (EASTMAN 491) seems a modest share of the cost of the technology that supports the assertion. And we do *not* assert that plain EASTMAN 491 does *not* meet the above-quoted specification.

Orders should be placed with Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company). For reprints of two of our publications on the preparation of high-purity silver halide crystals or to engage in brotherly banter on subjects like optical absorption edges and interstitial ions, address Eastman Kodak Company Research Laboratories, Physics Division, Rochester 4, N. Y.

Inside TV

Though you probably won't buy any yourself and though we hope you won't have to have any bought for you, you may find it useful in business to know that we now offer a product called KODAK Special TV Cinefluorographic Film, Type SO-210. This indicates the substantial presence and present health of a growing market based on electronic gear that fills an absolutely genuine, quite unpolitical, but sometimes unfortunate need. More and more radiological examinations being done in the hospitals today are dynamic instead of frozen. Doctors are looking at how blood and internal organs move. To keep down the radiation exposure to patients and themselves, they amplify the x-ray image with photoelectron-focusing intensifiers.

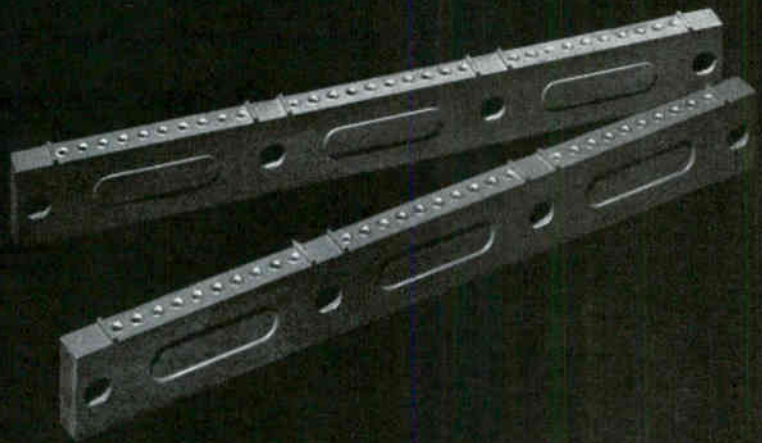
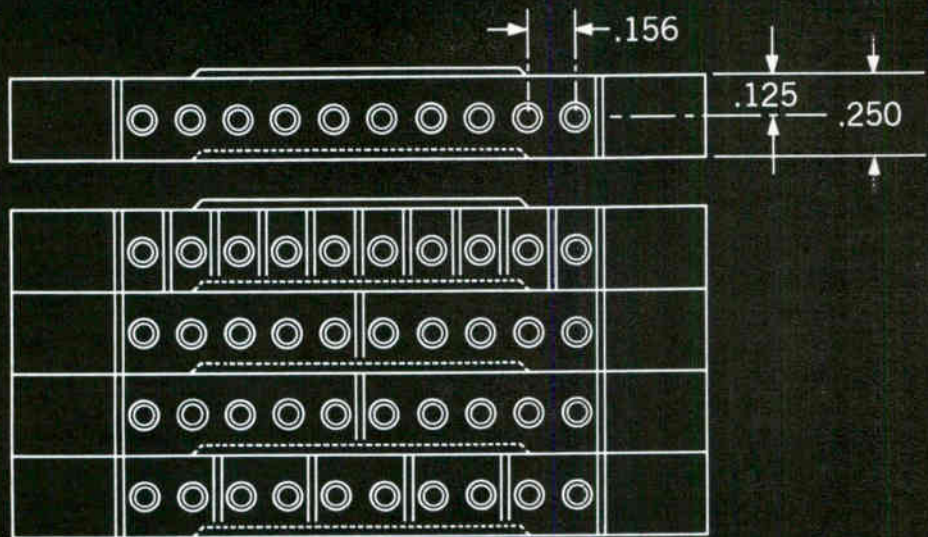
Presentation is often done today through TV circuits. Even if they watch the focused-electron picture direct, they need a photographic record. They have to watch the action over and over again to understand it. Therefore a button is now usually provided that starts a camera at the right moment so that the film can be projected over and over again instead of exposing the patient over and over again.

Our new addition to the line is intended for this work. It is fine-grain, blue-sensitive, suitable in speed and contrast, 16mm, perforated on both edges, wound emulsion in, on camera spool, Spec 449. If you want to be an actual customer, a convenient x-ray dealer will have to order no less than \$100 worth, which comes to some 40 100-ft rolls, delivered in about six weeks.

Prices subject to change without notice.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

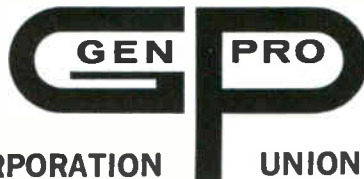
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Wherever multiple electrical connections must be made in limited space—whenever maximum flexibility in commoning is required—Gen-Pro taper pin terminal boards are your best answer. Designed to nest together for stacking, they offer from a single to 30 clearly numbered feed-through common connections—accept all standard taper pins. Barriers on board faces segregate common connections and increase creepage path. Mounting holes are elongated for easier installation and adjustment. Gen-Pro offers the widest range of molding compounds—phenolic, diallyl phthalate, or glass-filled alkyd. Taper pin sockets are available in commercial and military plating. Gen-Pro taper pin terminal boards meet MIL-S-901B.

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ATOMIC TEST BAN

What Does It Mean to Our Industry?

*Officials see slight
impact unless it starts
a trend to disarmament*

By RICHARD SMITH
McGraw-Hill World News

WASHINGTON — After eight years of false starts and frustrations, the USSR, the U.S. and Great Britain reached a nuclear test ban agreement last week. Only an unexpected renege by the Soviets, or a refusal by the U.S. Senate to ratify a treaty, can block it.

The agreement sidesteps the inspection issue (ELECTRONICS, p 26, Jan. 4, 1963) that blocked agreement in the past, by excluding underground testing from the ban.

The real significance could be more symbolic than anything else:

it could point toward more significant moves in East-West relations.

Within this broad framework, the agreement promises little immediate impact on the electronics and other defense industries, but it holds the seeds of major future change.

INDUSTRY CALM—No industry source informally canvassed by ELECTRONICS believes the ban will immediately effect much business. Most see it as an initial step toward more peaceful relations with Russia that would have to extend to general disarmament agreements and weaponry dismantlement before impact on defense business would be significant.

Administration officials, nonetheless, are sensitive to business opposition that might lessen the treaty's chances of ratification.

A joint government-industry meeting has already been set for August 13 under sponsorship of the Scientific Apparatus Manufacturers Association to discuss a ban's impact on atomic test instrumentation purchases.

One DOD official claims that a ban will put more emphasis than ever on detection capability and that radiation instrument sales could increase.

Of the industry's projected sales of \$11.8 billion in 1963, about \$50 million is directly tied to atmospheric test operations. Since government and industry sales are rising an average 10 percent a year, most officials conclude business lost as a result of the ban will be more than absorbed by the increasing sales rate.

WILL TREATY PASS?—It is still hard to tell whether the President can muster the necessary Senate votes. Some opposition is lining up in both houses of Congress.

Rep. Craig Hosmer argued last week that the ban is no ban at all, that the Russians could and would test in outer space and underground to perfect small tactical weapons and antimissile defenses.

Hosmer said that the Russians could break the treaty when they

Data Processing May Rise

BOSTON—Reaction of New England electronic companies to the nuclear test-ban proposal revolved in general around the themes that:

- Possibility of such a ban has been anticipated, has entered into their long-range planning

- Inspection and monitoring will provide alternative programs

- Treaty itself may even generate a new and massive program for exhaustive analysis of data from pre-treaty test shots

- It may also give a valuable preview of what problems might be

Raytheon, for one, has already invested heavily in information sciences R&D, inspection and monitoring, and has several arms-control study contacts.

An official of another electronics company said that data processing represents a much larger dollar expenditure than data acquisition in the area of nuclear tests. Point-

ing out that processing of data from previous tests is continuing at the present time, he suggested that the partial ban might even generate a massive program of data analysis to glean useful information from earlier shots.

EFFECT ON SATELLITES

BEDFORD, MASS.—High-altitude nuclear explosions and the resulting increase in radioactivity in space have damaged satellites in orbit (ELECTRONICS, p 22, Dec. 14, 1962). An atmospheric test ban would curtail this problem.

It would also eliminate the necessity for satellites to probe effects of atomic explosions on the atmosphere, according to Brig. Gen. B. G. Holzman, commander of Air Force Cambridge Research Laboratories. AFCRL has instrumented two such satellites to study the effects of the July 9 test in the Pacific. The second, which went up June 27, was revealed last week.

Holzman says, however, that AFCRL will continue to conduct research bearing on future Air Force communications, missile detection, command and control, navigation and guidance

CAN THEY CHEAT?

SANTA BARBARA, CALIF.—Clandestine nuclear tests could conceivably be made beyond the moon, according to Edward Tschupp, of General Electric's Tempo. The moon would hide the blast's light and the distance would make other detection techniques useless. Logistics for such a test would be formidable. To relay data back to earth would require a carefully placed satellite in the vicinity—close enough to measure the effects and far enough away to avoid being destroyed.

Space tests this side of the moon would light up the sky brighter than the sun. Vela satellites will be equipped with light sensors to detect sudden light of this magnitude.

Underwater cheating could be detected by seismic sensors, sonar, and tidal wave effect. The suspicious area could be tested for proof days or weeks later—such tests would almost certainly be in deep international waters.

Atmospheric tests could be detected by seismic reactions, blast wave pulse, and ionization. Aircraft can sample ionization up to 50,000 feet, balloons to 100,000 feet, and rockets to 100 miles

were ready for atmospheric tests of weapons that might give them a decisive lead in nuclear arms. The possibility of the U.S. losing its nuclear superiority is too great a risk to take, he concluded.

Administration replies are:

- U.S. will also continue underground testing and weapons production.

- Russian deep-space tests would be costly, not produce useful military results and be easily detected

- Antimissile defense systems are hard to develop (ELECTRONICS, p 16, May 10; p 24, March 8, 1963). The U.S. conducted experiments in the last test series and will continue theoretical investigations. There is no reason to believe that the Soviets are ahead and would benefit from a ban.

Senate supporters of the ban claim they have the necessary 67 votes for ratification. Advocates see it as a solution to the fallout buildup problem and a better chance for lasting peace.

NO WEAPONS CUTS—Since the administration intends to be ready to resume testing on 120 days notice indefinitely in case the treaty is abrogated, the effect on weapons programs is moot. Actual weapons fabrication presumably will continue at pre-ban rates. AEC spending on weapons is just under \$1 billion a year. No personnel cutbacks are slated and more underground shots are being planned. AEC says

its field budget may not be decreased at all.

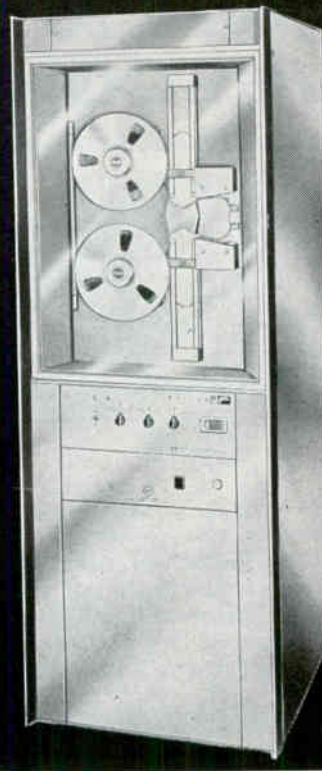
DOD is responsible for the storage, deliverability and carrying out detection and identification programs of nuclear weapons tests. Again, the ban is not expected to cut back production of missile and manned-aircraft weapon delivery systems. There would have to be broader disarmament agreements before production of weapon systems and warheads were reduced or existing systems dismantled.

VELA PROJECT — DOD's Advanced Research Projects Agency (ARPA) is responsible for Project Vela, the national program for improving U.S. capability in detecting nuclear tests. A total of \$101.6 million has been appropriated for Vela program since fiscal 1960. This year's \$41 million goes toward upgrading seismological observatories world-wide, monitoring U.S. underground explosions, developing on-site inspection techniques, prototype electronic components, and so on. The fiscal 1964 request of \$20 million will not be reduced as a result of the ban and will be spent to continue existing programs.

The first budget item that may be pinched by a test ban is DOD's civil defense program and its plans for 235 million shelter spaces outfitted with radiation survey meter kits. But civil defense officials are standing by their budget requests for fiscal 1964.

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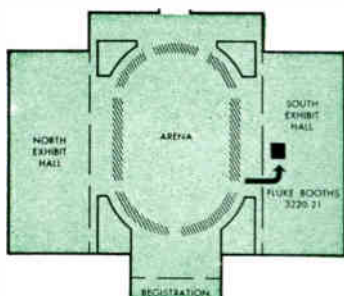


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- Model 803D differential voltmeter
- Model 831A microvolt potentiometer
- Model 840A null detector
- Model 710B universal impedance bridge
- Model 413C high voltage power supply
- Model 430A high voltage power supply
- Model 313A solid state DC calibrator

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- Improved commercial models of Fluke decade potentiometers, decade rheostats and vernier potentiometers.

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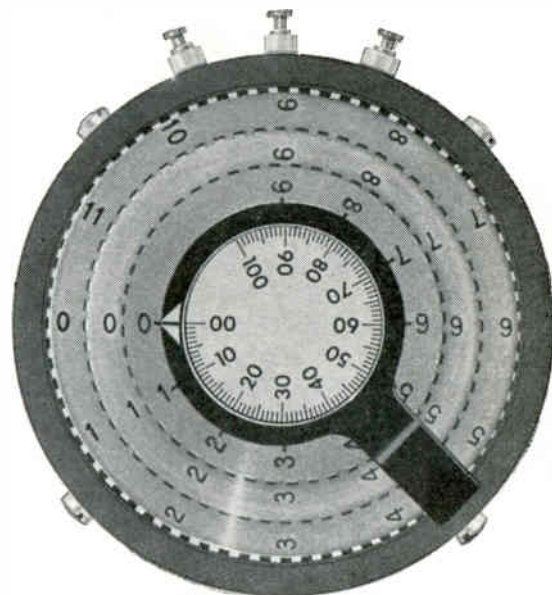
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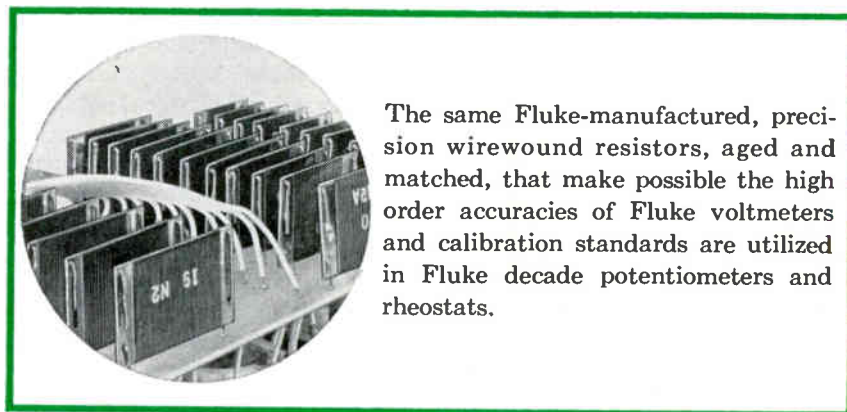
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Improvements resulting from the development of militarized units have now been incorporated into the design and production of new commercial Fluke decade potentiometers and rheostats. Accuracy has been improved as much as two to one. Models are available in a range of accuracies to meet your most exacting requirements, with linearities to $\pm 0.0025\%$ and resistance accuracy to $\pm (0.025\% + \text{one dial div.})$. Prices involve no premium for added capabilities and reliability.



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TLX, 852

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Features common to all models are infinite input resistance at null; in-line readout with automatic lighted decimal; front panel DC polarity switch; standard cell reference (zener diode optional); taut band suspension meter and flow-soldered glass epoxy printed circuit boards.

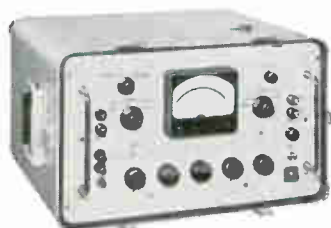


Choose the degree of accuracy that meets your need...

	801B	825A	821A	803B	803D	823A
DC ACCURACY ±% of input voltage	0.05%	0.02%	0.01%	0.05%	0.02%	0.1%
AC ACCURACY ±% of input voltage				0.2%		0.01%
Models	801B	825A	821A	803B	803D	823A
INPUT RANGE	0-500V	0-500V	0-500V	0-500V	0-500V	0-500V
FREQUENCY RANGE	20 cps-10 kc	5 cps-100 kc	5 cps-100 kc
MAXIMUM FULL SCALE SENSITIVITY	10 mv	1 mv	1 mv	10 mv DC 1 mv AC	1 mv	1 mv
MAXIMUM METER RESOLUTION	50 uv	5 uv	5 uv	50 uv DC 5 uv AC	5 uv	5 uv
REFERENCE	Std. cell (zener diode optional)	Std. cell (zener diode optional)	Standard cell	Std. cell (zener diode optional)	Std. cell (zener diode optional)	Standard cell
PRICE Cabinet model	\$485.00	\$590.00	\$795.00	\$875.00	\$1,100.00	\$1,300.00
Rack model	\$505.00	\$610.00	\$815.00	\$895.00	\$1,120.00	\$1,320.00

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PRICE: \$1745.00

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±0.1% of input or 0.5 mv whichever is greater, below 0.1V
NULL RANGES: ±10, ±1, ±0.1, ±0.01V
INPUT IMPEOANCE: Infinite at null from 0 to 500V
MAXIMUM METER RESOLUTION: 50 uv
REFERENCE: Temperature controlled Zener diode

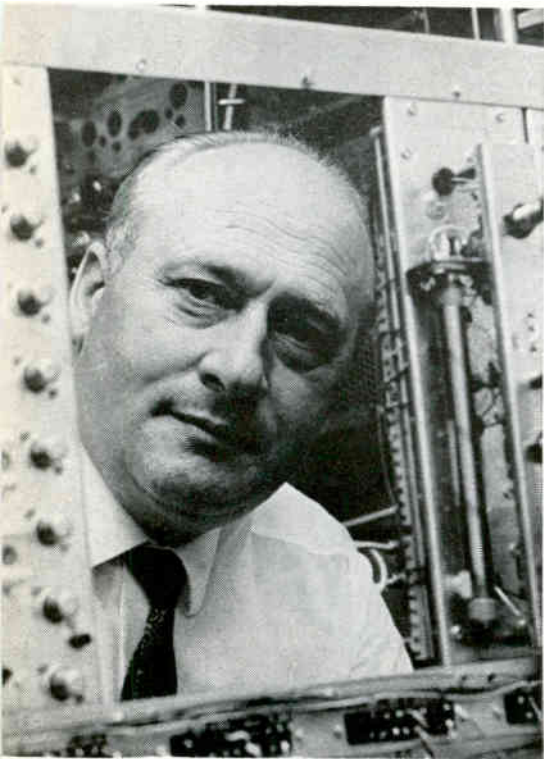
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PR 6-1171 TWX 206-879-1864 TLX 852 Cable: FLUKE

Europe's Color-Tv

Gets a New Entry from Germany



WALTER BRUCH, who developed the PAL color tv system in the Hanover, Germany, research laboratories of Telefunken GmbH, peers through a unit of the experimental equipment now undergoing tests

Phase alternation line system claims freedom from phase distortion

BONN—A strong new contestant in Europe's search for a color-tv standard system is Telefunken's PAL (phase alternation line). Already demonstrated before a working committee of the European Broadcasting Union (EBU), the concept has more hurdles ahead, including a forthcoming test by BBC.

It is one of three systems EBU is evaluating. The other two are the U.S.'s NTSC system and the French SECAM (sequential with memory)—for details, see *ELECTRONICS*, p

57, May 6, 1960).

The West German approach claims several advantages—

- Combines the best features of NTSC with a new freedom from phase distortion caused by the typical transmission path (SECAM's primary advantage lies here, too)

- Surpasses both SECAM and NTSC by transmitting both color signals completely and exploiting four signals, two each for one line, to provide the color information

- Insensitive to band limitation, such as single-sideband distortion

- Hue is faultlessly transmitted, making receiver readjustment from one station to another unnecessary (NTSC could be weak here)

- Reproduction of color pictures recorded on tape is improved over NTSC

- Compatible with existing monochrome and with Europe's 625-line system

- Reception on a simplified version of the PAL receiver attains most of the important system merits.

HOW IT WORKS—Color hue and saturation information is superimposed upon a carrier and mixed with the luminance signal—the signal important for monochrome-set reception.

In the NTSC system, hue and saturation information are superimposed upon the color carrier in quadrature modulation. The a-c signal is phase and amplitude modulated. Phase position determines hue and the amplitude the color saturation at the receiver. Telefunken claims that hue variations result from phase variations in transmitter, receiver or along the transmission path and also from one station to another.

In the PAL system the phase of one of the two modulations, composing its quadrature modulation, is switched over at the transmitter by 180 degrees from line to line.

At the receiver, Telefunken says,

New Camera Ready for Color Decision



COLORFUL young lady in multicolor dress is used by Marconi during London demonstration of new separate-luminance color-tv camera. Marconi says camera is suitable for NTSC, SECAM and PAL systems. It uses three $4\frac{1}{2}$ -inch image orthicons, for luminance, red and blue signals. Green is derived from these three signals

Competition

By RICHARD MIKTON
McGraw-Hill World News

its demodulation method recovers color information without transmission path distortion. Color information transmitted during a line is delayed by the time required for the line, then combined in equal phase with the information of the following line. Carrier frequency summation in correct phase of the two different line data separates one signal uninfluenced by phase distortion and subtraction separates the other signal.

A delay line, similar to that used in the SECAM receiver, feeds the delayed signal into a Wheatstone bridge where it is added to or subtracted from the undelayed signal. A glass rod fitted with ceramic transducers delays the 4.43-Mc color signal ultrasonically about 64 microseconds.

The two superimposed signals shifted by 90 degrees in one line can be considered complex quantities and are reshaped in the transmitter in the subsequent line such that the conjugated complex quantity arrives at the receiver. The addition of two such quantities gives double the real component and subtraction provides double the imaginary component.

The transmitter switching device requires a receiver modification, a simple diode circuit to repole one of the two signals from line to line in synchronism with the transmitter.

COMPATIBILITY — The three European monochrome systems differ in video band widths. PAL proponents claim it can trim program signals to proper width without introducing single-sideband distortion.

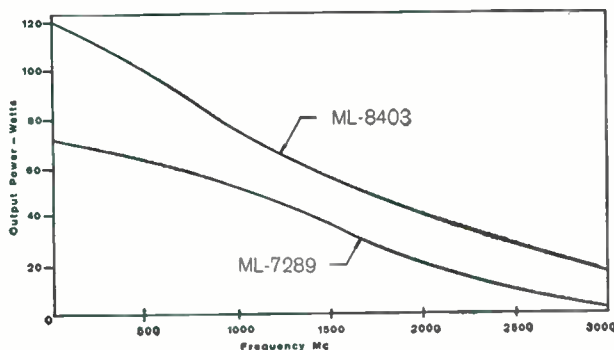
When phase distortions over the transmission path are not too great, the demodulator delay line can be omitted. Besides claiming interference-suppression and noise figures comparable to NTSC, Telefunken says that a PAL receiver can receive NTSC signals by operating a simple switch requiring no accessories.

UHF



NEW

Approximate Power Output CW
ML-8403 vs ML-7289



50% more cathode current... & Frequency stable performance

50% more cathode current (190 vs 125 ma) from the Phormat (matrix) cathode of the new ML-8403 planar triode allows higher powered performance—to nearly 120 watts CW—at normal plate voltages. A frequency stable anode permits variable duty cycle without noticeable shift in frequency. For ML-8403 ratings write The Machlett Laboratories, Inc., Springdale, Conn. An affiliate of Raytheon Company.



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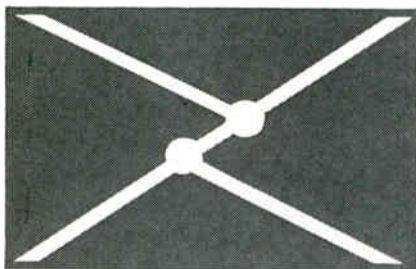
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Fork Drives ILS Antenna

*All-weather landing
system uses torsion
bars for scanning*

TORSIONAL tuning fork is used as the antenna drive system for an all-weather instrument landing system now under development for the FAA by the Airborne Instruments Laboratory Division of Cutler-Hammer.

It is one of several all-weather systems the FAA is evaluating at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City. The AIL system, being developed under a \$1-million contract, is expected to be placed in operation at NAFEC within the next two years.

The antenna drive system (see figure) operates much the same as a tuning fork, with rotation about a central axis rather than lateral motion. A fairly large antenna can

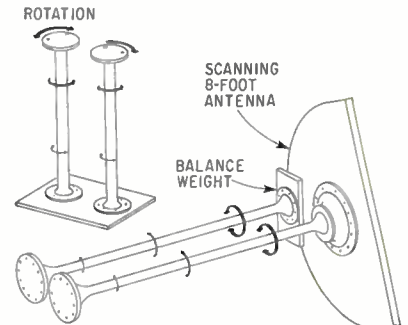
Laser Reflectors



FUSED SILICA PRISMS on S-66 ionospheric satellite to be launched after August 15, possibly in September, will reflect laser beam striking spacecraft array from any angle back to its source, to provide range data (*ELECTRONICS*, p 20, Sept. 7, 1962; p 14, Nov. 23, 1962)



ANTENNA drive mounted on cabinet of glide-slope radar



BASIC torsional tuning fork (top) is modified for resonant torsion-bar antenna system (bottom)

be scanned through 10 degrees of arc using a relatively small amount of electrical energy to maintain oscillations. The AIL system is designed to oscillate at approximately 5 cps, and two or more antennas can be operated synchronously.

Angular position data is pulse-coded into the 15-Gc beam by the AIL system, and, through the use of time-sharing techniques, only a single frequency channel is required for glide-slope, glide-path, and distance data. Present systems use separate frequencies for each type of data, AIL says.

BRITONS UNITE

LONDON—Nine trade associations and eighteen major electronics companies have jointly formed a Conference of the Electronics Industry. The conference will provide a forum for discussion of common problems within the industry and act as a central body for the industry in industry-government discussions

CIRCLE 25 ON READER SERVICE CARD →



This Tiger flies to SCHPLNDBSCP B

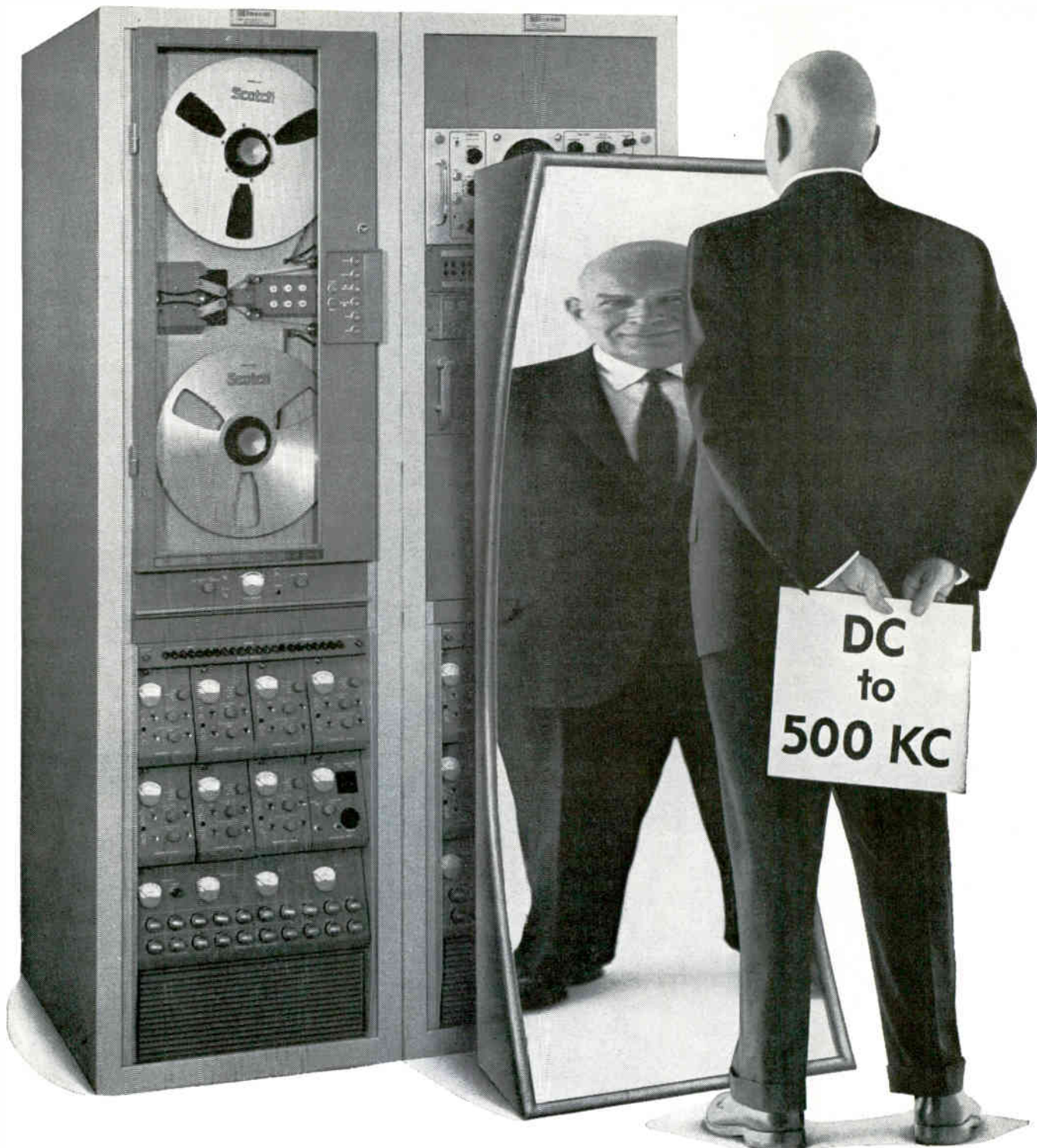
If you want to ship to SCHPLNDBSCP B, however, you won't find it on the map. That's short for some of the major points we serve: San Francisco, Chicago, Hartford, Philadelphia, Los Angeles, New York, Detroit, Boston, Seattle, Cleveland, Portland, and Binghamton. In fact, you can get Tigers' overnight freight service to

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With this in mind, Motorola scientists and engineers have developed a high-current power transistor for high-speed switching applications which will enable you to get the highest possible efficiency, and make every precious millivolt count.

Designated 2N2728, this new Motorola device features an extremely low saturation resistance of only 0.0015 ohms . . . less than that of one foot of 12-gauge copper wire . . . resulting in a 0.075 Vdc typical saturation voltage at 50 amperes collector current. This characteristic, plus its fast switching time, makes this device ideal for power converters using solar cells, fuel cells, thermoelectric generators, sea cells, or 1.5 volt batteries.

Power loss in this transistor in the saturated condition is less than half that of power transistors previously available for similar applications.

The rugged design of the Motorola 2N2728 (in the proven TO-36 package), permits its use in the roughest of applications such as air-dropped sonobuoys, military field vehicle equipment, or in missiles and satellites. If your circuit design calls for an extremely low voltage power supply, *don't waste a millivolt!* Specify the Motorola 2N2728 germanium power transistor.

LOOK AT THESE PERFORMANCE RATINGS!

Characteristic	Symbol	Min	Typ	Max	Unit
DC Current Transfer Ratio $I_c = 20 \text{ A}, V_{CE} = 2 \text{ V}$	h_{FE}	40	—	130	—
Collector-Emitter Saturation Voltage $I_c = 50 \text{ A}, I_b = 5 \text{ A}$	$V_{CE(sat)}$	—	.075	0.1	Vdc
Base-Emitter Voltage $I_c = 50 \text{ A}, I_b = 5 \text{ A}$	$V_{BE(sat)}$	—	0.85	1.0	Vdc
Common Emitter Cutoff Frequency $I_c = 20 \text{ A}, V_{CE} = 2 \text{ V}$	f_{∞}	3	4.5	—	kc

This new device is immediately available from your local Motorola Semiconductor Distributor or District Office. For complete information on the 2N2728, write: Technical Information Center, Motorola Semiconductor Products Inc., P.O. Box 955, Phoenix 1, Arizona.



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S-63.040

CIRCLE 27 ON READER SERVICE CARD



NUMBERS, service symbols and letters are made up of seven vertical strokes of magnetic ink



BASIC READOUT equipment is reading head (foreground), preamplifier and recognition circuits



French Find 7 Lucky Number

Sales of CMC 7 magnetic character reading systems snowballing in Europe

By ARTHUR ERIKSON

McGraw-Hill World News

PARIS—After breaking into the majority of European banks this year, Compagnie des Machines Bull has started to move into other fields with its CMC 7 magnetic character.

Already in the works or in sight are applications in the French and German postal check systems, Austrian telephone system billing, the Norwegian lottery and several French government departments.

Bull is selling a check-sorting machine based on the CMC 7 character plus peripheral equipment to feed check data into a Gamma 30 electronic bookkeeping system.

Bull has put its basic patent on the character into the public domain and is now offering to other data-handling equipment makers the basic readout hardware.

AMERICAN OUT—The banks decided to use CMC 7, not the American E 13 B character, after both were compared at the French Post Office Department's Centre National d'Etudes des Telecommunications. CNET gave the CMC 7 the edge mainly for its more simple readout circuitry. The magnetic head has a single reading element compared to 30 for one E 13 B system.

CNET also saw these advantages for the CMC 7:

- Badly printed characters can't be read, so won't be read wrongly
- A full 26-letter alphabet, 10 digits and 5 service symbols
- Characters look like ordinary printing

CMC 7 symbols, all $\frac{1}{8}$ -inch high as for the E 13 B, are made up of seven vertical strokes of magnetic ink that establish a combination of six short and long (0.3 and 0.5 mm) intervals. An extra-long interval (> 0.67 mm) separates characters.

CODE READER — The reading head senses flux changes as ink strokes pass under it. Intervals between stroke passages are measured by voltage comparison to switch to 0 or 1 binary state six corresponding flip-flops.

Because vertical stroke heights differ making signal amplitudes vary, the head output signal is differentiated. Input to the comparison circuits depends on times of positive and negative pulse maximums as leading and trailing edges of the stroke pass the head. An amplitude threshold blocks spurious signals.

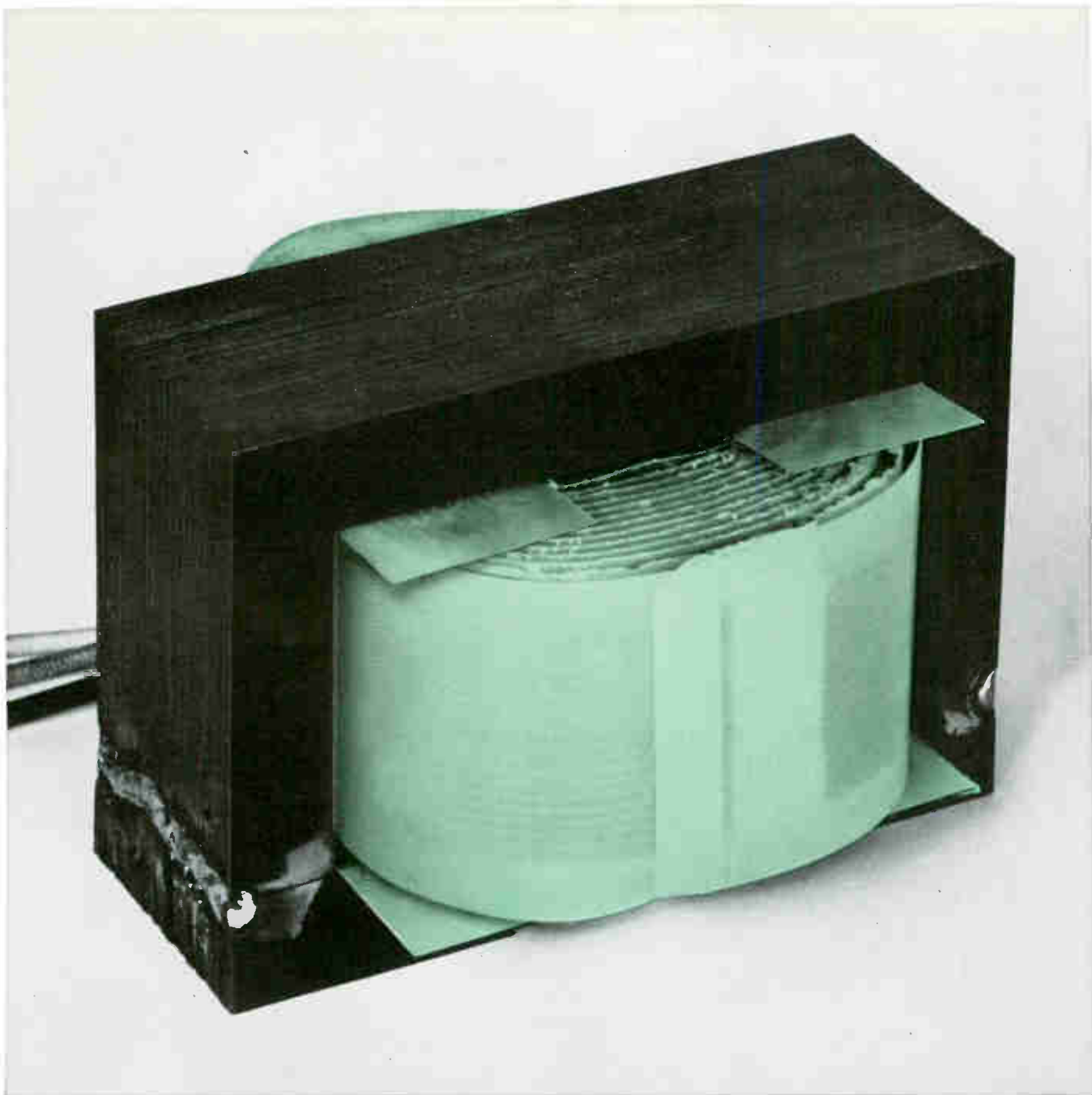
To reduce rejects, there are two independent logic channels, one sensitive and one attenuated. The sensitive channel, with a differentiated signal threshold of 0.14 v is normally used. But if parasite signals make the result incoherent, the attenuated channel (0.5 v threshold) is analyzed and read out if it contains a coherent code.

To check on readout correctness, both leading-edge and trailing-edge pulses are treated separately in each channel and the two sets of intervals compared.

Standard reading speed is 1.2 or 3.81 m/sec, but equipment can be adapted to between 0.7 and 14 m/sec. Magnetic density of the ink can vary from $\frac{1}{2}$ to 2 times standard.

CODE 2/6							CODES 1/6 AND 3/6													
1	2	3	4	5	6		1	2	3	4	5	6	1	2	3	4	5	6		
1	1	0	0	0	0	7	0	1	0	0	0	A	0	1	1	1	0	0	N	
1	0	1	0	0	0	3	1	0	1	0	1	B	1	0	0	0	0	0	O	
1	0	0	1	0	0	4	0	0	0	1	1	1	C	0	1	0	1	1	1	P
1	0	0	0	1	0	1	1	0	0	1	1	0	D	1	1	1	0	0	0	Q
1	0	0	0	0	1	SI	1	0	1	1	0	0	E	1	0	1	0	0	1	R
0	1	1	0	0	0	2	0	0	1	0	1	1	F	1	0	0	1	0	1	S
0	1	0	1	0	0	9	1	0	0	0	1	1	G	0	1	0	0	1	1	T
0	1	0	0	1	0	8	0	0	0	1	0	0	H	1	1	0	1	0	0	U
0	1	0	0	0	1	SI	0	0	0	0	0	1	I	1	1	0	0	0	1	V
0	0	1	1	0	0	0	0	0	1	0	0	0	J	0	1	0	1	0	1	W
0	0	1	0	1	0	6	0	1	1	0	1	0	K	1	1	0	0	1	0	X
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0	0	0	0	1	1	SV														

CODES FOR CMC 7 characters. Digits and symbols have two long intervals, letters have either one or three long intervals



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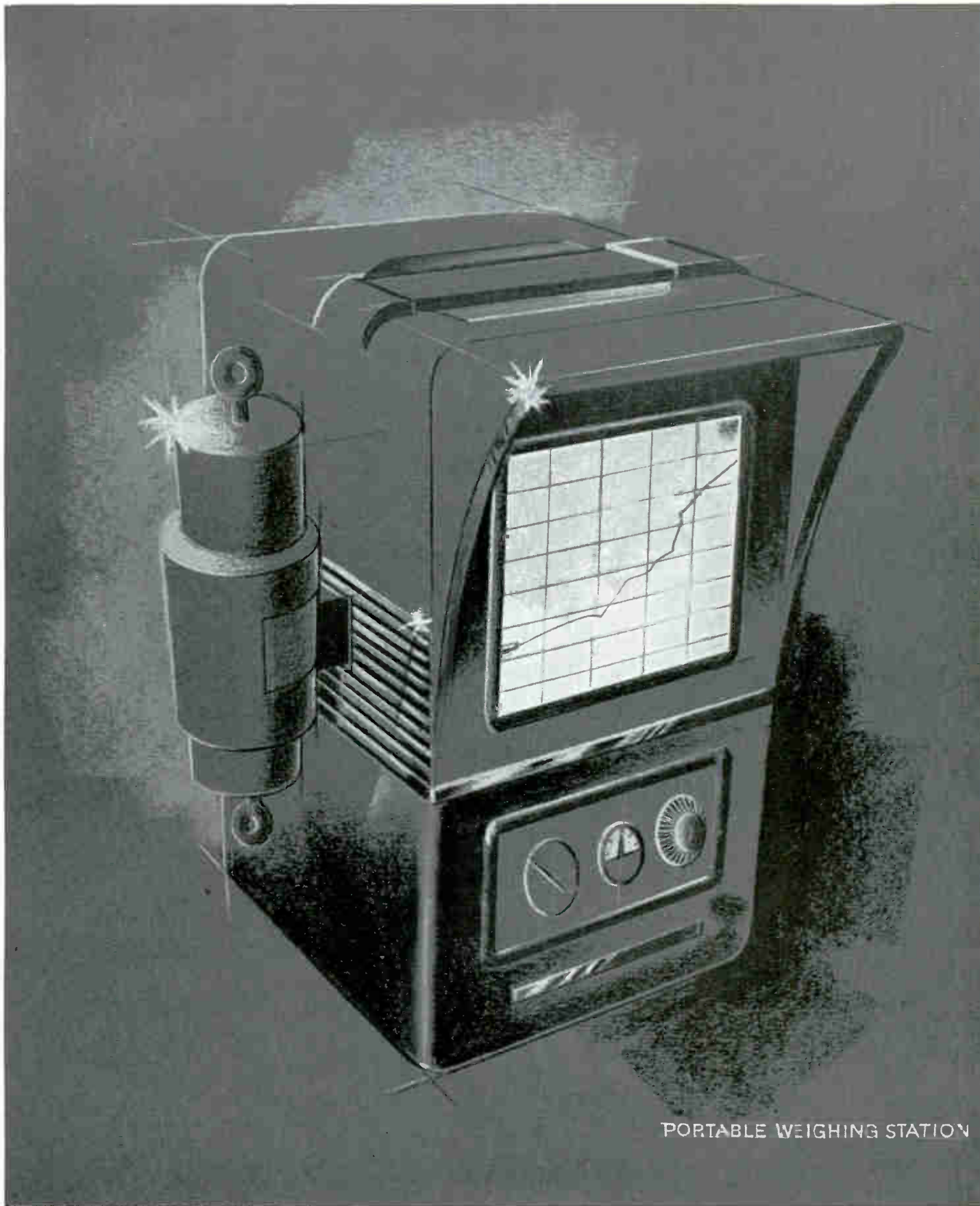
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 Duration of peak current _____ MA
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 Type of use: Standby _____
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 Depth of discharge _____ %

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 Type term no.s _____ Locations of Terminals: _____

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Name _____ Position _____
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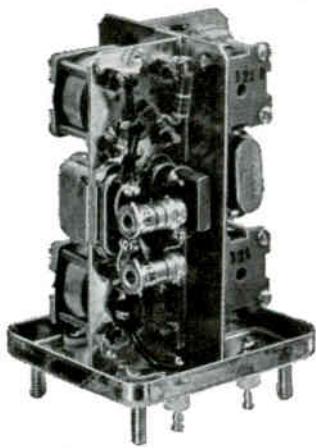
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ELECTRONICS DIVISION

TRANSMITTING antenna below helicopter transmits tv signals while camera peers out window

RECEIVING antenna on roof of NHK Technical Laboratories



For Tv — A

Slaving airborne and ground antennas helps raise range to 80 Km

By CHARLES COHEN

McGraw-Hill World News

TOKYO—Range of helicopter relay stations for remote-pickup tv programs is greatly increased by a directional antenna system demonstrated here last month by NHK, the government broadcasting system.

NHK expects the new system will be especially useful for covering the forthcoming Olympic games in Tokyo. The airborne antenna keeps pointing at the ground station while the helicopter follows the event being relayed. The helicopter can relay signals from widely scattered pickup trucks—whose signals might otherwise be blocked by hills or buildings—or can carry a camera for direct pickup.

In an earlier system, lower power and use of a nondirectional antenna limited range to about 4 Km. Range of the directional system is 80 Km (see table).

ANTENNA CONTROL—The base station operator points the receiv-

ing antenna at the helicopter and manually adjusts azimuth and elevation. Common reference bearing is the earth's magnetic field. Control frequency is 3.18 to 3.5 Kc.

The receiving antenna's azimuth angle θ_r is transmitted to the helicopter as the command signal. The transmitting antenna hanging from the helicopter rotates until its azimuth θ_t matches and it points at the receiver.

For transmission and comparison, θ_r and θ_t are converted to audio frequencies f_r and f_t . The transducers are variable resistors whose rotors are coupled to the rotating antenna axes. In the helicopter, the stator is coupled to a flux valve by a servomotor, so it always points in the same direction regardless of helicopter motion. A voltage proportional to the differ-

RELAY SYSTEMS COMPARED

	OLD	NEW
Transmitter output	2 w	5 w
Max. freq. dev.	± 1 Mc	± 2 Mc
Transmitter antenna gain	0	11 db
Rec. antenna gain	18 db	20 db
Rec. noise figure	13 db	7.3 db
Effective range	4 Km	80 Km

BASE STATION operator keeps receiving antenna pointing at helicopter



Flying Relay

ence between f_r and f_t controls the d-c servomotor that rotates the transmitting antenna. Error is ± 3 deg stationary, ± 10 deg while in rotation.

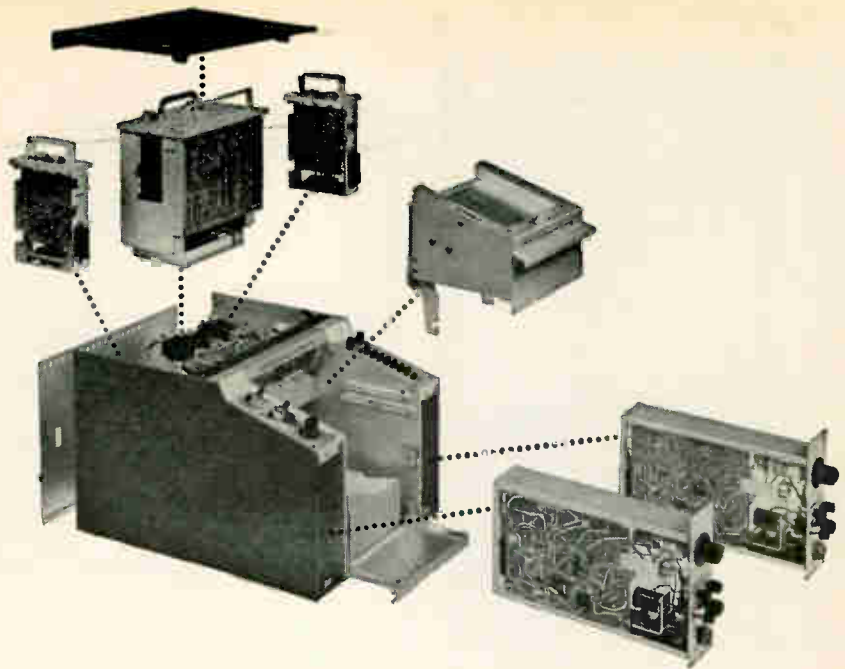
SOUND AND PICTURE — Command signal is transmitted to the helicopter by a 25-w transmitter. A voice communications channel is multiplexed on the command link.

From the helicopter, voice communications with the base station are by pulse-amplitude modulation of the tv signal sync pulses. The helicopter transmits a 775-Mc f-m picture signal.

One-Pound Laser Sends Messages One Mile

RAYTHEON has developed a portable, one-pound laser, capable of transmitting voice signals up to one mile. The device will be able to send more messages, or tv signals, over longer distances when more sophisticated infrared detectors are developed. Wider bandwidths would also permit the laser to be used as a computer link, Raytheon said.

Operating on a 3.5-micron wavelength, the laser signals travel through the atmosphere with relative ease. Battery power is used.



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MEETINGS AHEAD

AEROSPACE SUPPORT INTERNATIONAL CONFERENCE & EXHIBIT, IEEE, ASME; Sheraton-Park Hotel, Washington, D. C., Aug. 4-9.

INTERNATIONAL ELECTRONICS CIRCUIT PACKAGING SYMPOSIUM, University of Colorado, et al; at the University, Boulder, Colo., Aug. 14-16.

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IEEE; Cow Palace San Francisco, Calif., August 20-23.

DATA PROCESSING NATIONAL CONFERENCE & EXHIBITION, Association for Computing Machinery; Denver Hilton Hotel, Denver, Colo., Aug. 27-30.

AUTOMATIC CONTROL INTERNATIONAL CONGRESS, International Federation of Automatic Control; Basle, Switzerland, Aug. 27-Sept. 4.

MILITARY ELECTRONICS NATIONAL CONFERENCE, IEEE-PTGMIL; Shoreham Hotel, Washington, D. C., Sept. 9-11.

ELECTRICAL INSULATION CONFERENCE, IEEE, NEMA; Conrad-Hilton Hotel, Chicago, Sept. 10-14.

JOINT ENGINEERING MANAGEMENT CONFERENCE, IEEE, ASME, et al; Biltmore Hotel, Los Angeles, Sept. 12-13.

INTERNATIONAL ASSOCIATION FOR ANALOG COMPUTING, AICA; Brighton College of Technology, Lewes Rd., Brighton, England, Sept. 14-18.

INDUSTRIAL ELECTRONICS ANNUAL CONFERENCE, IEEE, ISA; Michigan State University, East Lansing, Mich., Sept. 18-19.

NATIONAL POWER CONFERENCE, IEEE, ASME; Netherland-Hilton Hotel, Cincinnati, Ohio, Sept. 22-25.

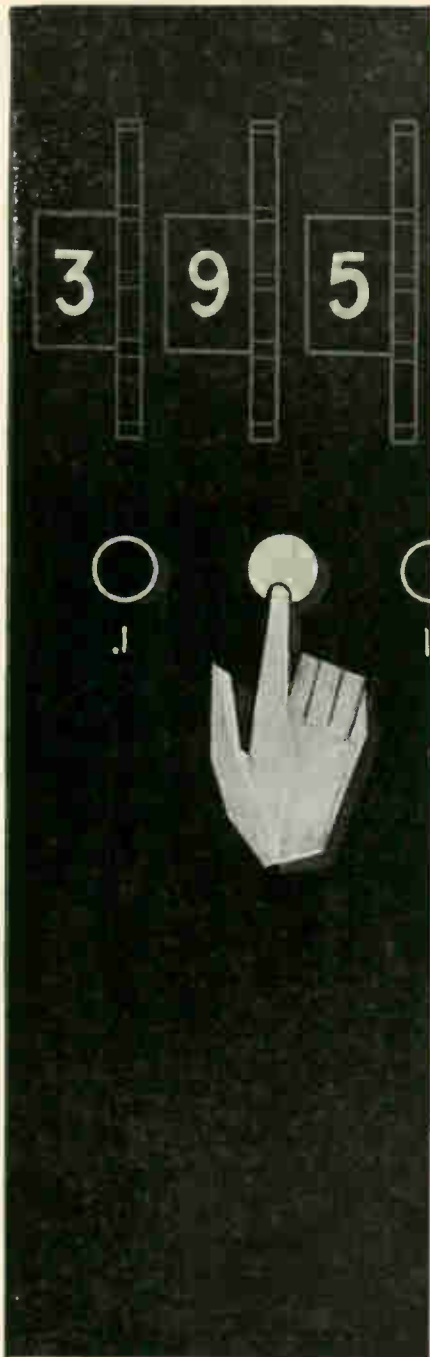
INTERNATIONAL TELEMETERING CONFERENCE, IEEE, ISA, et al; London, England, Sept. 24-27.

PHYSICS OF FAILURE IN ELECTRONICS SYMPOSIUM, Armour Research Foundation and Rome Air Development Center, Illinois Institute of Technology, Chicago, Sept. 25-26.

ELECTROCHEMICAL SOCIETY FALL MEETING, ECS; New Yorker Hotel, New York, Sept. 29-Oct. 3.

ADVANCE REPORT

THE 1964 ELECTRONIC COMPONENTS CONFERENCE, EIA, IEEE, ASQC; Washington, D. C., May 5, 6, 7, 1964. Nov. 15 is deadline for submitting 3 copies of 500 word abstracts to Dr. John J. Bohrer, technical program chairman. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Papers to be presented in the fields of capacitors, resistors, wiring and cabling, interconnections and connectors, reliability, thin film devices, and materials.



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Automatic circuitry adjusts to input signals over a 40 db dynamic range. The unit incorporates a unique digital loop filter that maintains bandwidth proportional to bit rate at all frequencies. Output of the synchronizer is a reshaped, noise-free, serial PCM signal and a set of clock signals phase coherent with the output data.

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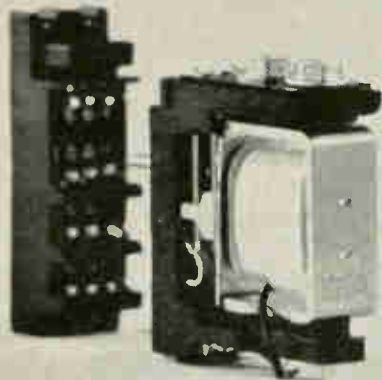
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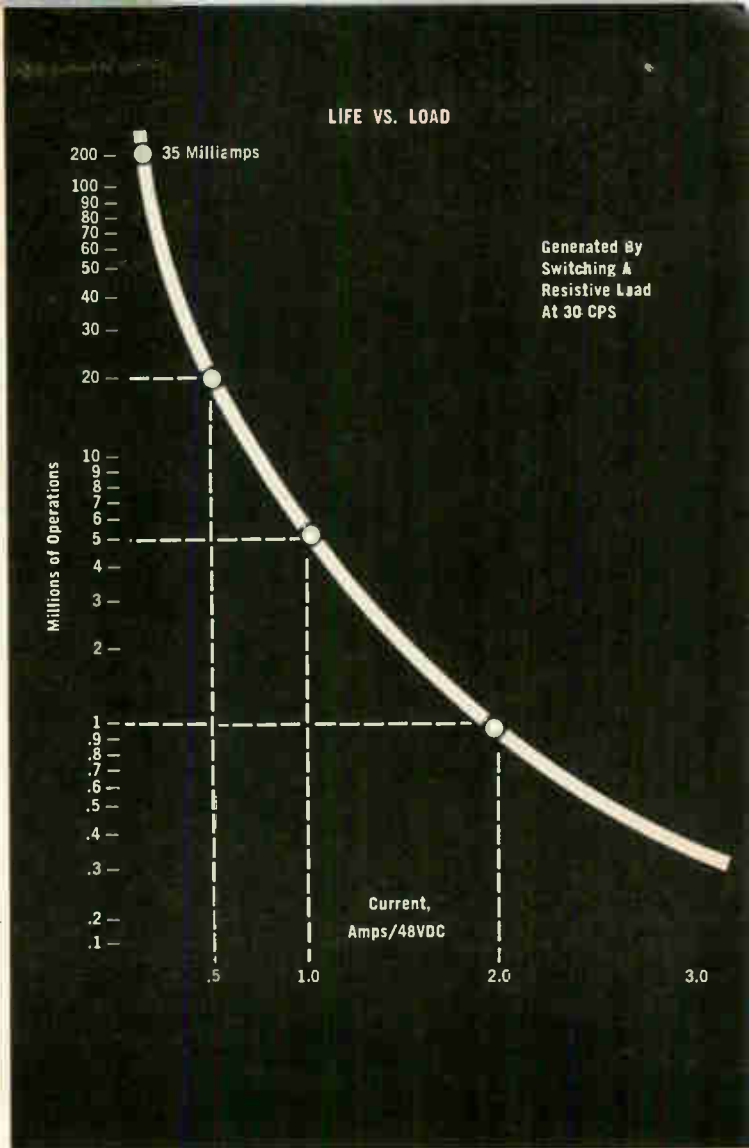
Operate Speed: As fast as 4 ms.

Release: 5 ms.

Contact Arrangement: 4, 6, and 12 PDT Form C, 4, and 6 PDT latch.

Contact Rating: Vary with life requirements (see chart).

Reliability: 1 error per over 400 million contact closures



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TC retrace—within 5ppm of the curve at any temperature; drift less than 0.1% or 0.1 pf.

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I.R.—tops 500 ohm farads at 125°C ., high over entire temperature range.

Losses—low over entire range,

D.F. is less than 0.001 at 1 kc and 25°C .

Life—less than .5% capacitance change after 2000 hours at 1 mc or 1 kc at 125°C . and 150% of full rated voltage; D.F. at 125°C . is less than 0.007 and I.R. is greater than 10^{10} ohms.

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Price—up to 60% less than you'd pay for the only other comparable capacitor—and that's our high-relia-

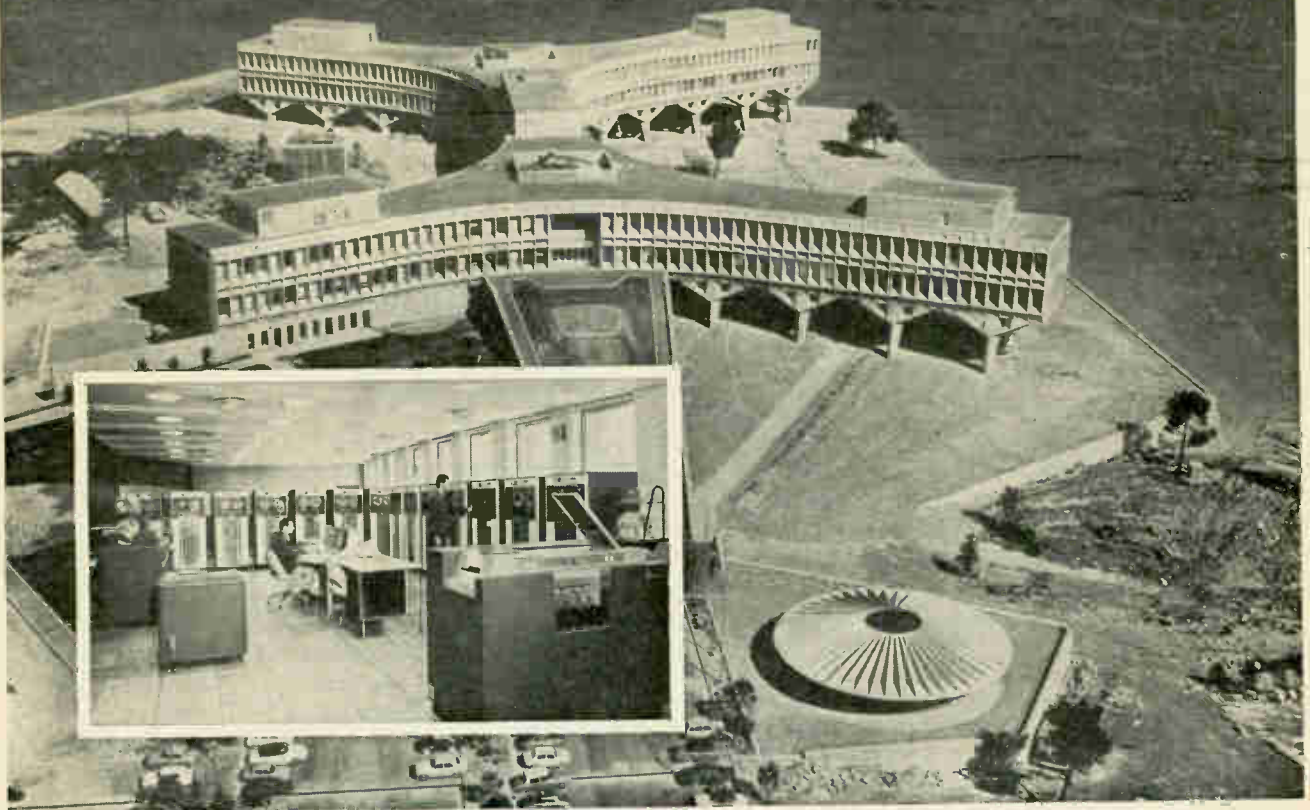
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LONG-RANGE DATA transmission is one of the key research areas at IBM's recently dedicated La Gaude Laboratory near Nice, France. Circuit costs may be cut with thin-film logic elements that are under development

MICROELECTRONICS AROUND THE WORLD

European and Japanese manufacturers are looking to integrated circuits for industrial computers, process control systems and—in a few cases—consumer items

An ELECTRONICS Staff Report

LARGE-SCALE APPEARANCE of microelectronics on the commercial scene may come first in Europe and Japan. Major companies there are taking a hard look at integrated circuits for industrial electronics applications. This could bring about the volume requirements that U. S. manufacturers predict will reduce integrated circuit prices below that of conventional components.

An on-the-spot check by McGraw-Hill World News correspondents confirms reports of "tremendous" in-

terest in applying integrated circuits to commercial computers and process control systems (ELECTRONICS, p 22, May 10). This interest is spurred, especially in Europe, by the newness of their facilities and the strong push to automation arising from the shortage of skilled labor and climbing wage scales.

While actual applications are limited at present, some prototype equipment is being developed and most electronics companies expect significant applications to appear within the next five years. How-

ever, they are reticent to reveal details on specific equipment or techniques.

Like their U. S. counterparts, European and Japanese firms cite expectations of reduced cost, increased reliability and small volume as the main reasons for their interest in microelectronics. There is also general agreement that substantial consumer usage is further off. However, some Japanese firms are already fabricating prototype microelectronic items for the consumer market.

Here are the highlights of reports from six countries:

GREAT BRITAIN

Multimillion-dollar industrial electronics market predicted for microcircuits

LONDON—Silicon integrated circuits are on the verge of large-scale acceptance by British equipment makers. Strangely enough, first applications are likely to be more prolific in professional equipment than in military systems. But at present no one is saying what these commercial applications will be or even which firms are actively experimenting with integrated circuit designs.

The same close-mouthed attitude covers thin-film circuit applications. Only one manufacturer, Elliott-Automation Ltd., has announced any production uses for these techniques. In their new 503 computer, thin-film circuits will be used experimentally in the computer peripheral equipment. Another application is the switchover to thin-film RCTL sub-units for Elliott's Minilog package logic system. Third application revealed by Elliott uses thin-film units in a gyro stabilizer system.

In the integrated circuit area, the only announced applications come from Government research establishments. At the Royal Armament Research and Development Establishment, integrated circuits are being used in a high-speed tape comparator, Fig. 1, to locate and display differences between two 5-digit tapes. The Royal Radar Establishment has a tunable solid-state filter operating between 15 and 90 Mc. The filter makes use of the distributed capacitance associated with a diffused silicon resistor to form a twin-T network whose center frequency is shifted by altering the voltage on the voltage-dependent $p-n$ capacitance.

But while few applications have been disclosed, there is plenty going on under the surface with five major companies, Standard Telephones and Cables Ltd. (an ITT subsidiary), Ferranti, Plessey, Texas Instruments and SGS-Fairchild offering silicon integrated circuits. Well advanced commercially is Texas Instruments with prototype applications already under test on industrial digital servos, commercial computer designs, airborne radar units, aircraft surface control systems and navigation computers. Plessey is finalizing a fast logic application for a 30-Mc counter and developing multi-emitter logic with good noise rejection capabilities.

THE MARKET—All five suppliers assess today's integrated circuit potential as lying firmly within

ON THE SCENE

Electronics is an international business and its coverage requires international footwork. This point is demonstrated by the accompanying story which resulted from the efforts of McGraw-Hill World News correspondents in six nations who contacted 50 electronics companies and filed 7,000 words of copy—all within a few weeks. The reporters: Derek Barlow (London), Charles Cohen (Tokyo), Arthur Erikson (Paris), Marc Messina (Milan), Richard Mikton (Bonn), and Robert Skole (Stockholm). Their copy was coordinated in New York by Senior Associate Editor Michael F. Wolff

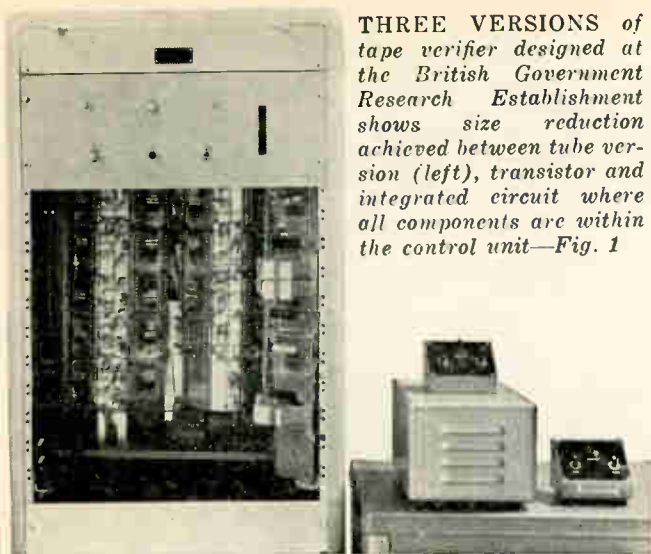
the professional equipment rather than military systems. Confirming this view are current studies on integrated circuit applications for electronic telephone exchanges. One manufacturer says that compared to commercial applications of integrated circuits in the U. S., the U. K. commercial market will appear faster and be broader based.

British circuit suppliers are confidently talking about a multimillion dollar market in the U. K. Guesses as to when the upsurge will start vary from manufacturer to manufacturer. One company, Semiconductors Ltd., (a subsidiary of the Plessey group) anticipates its turnover in 1967 in integrated circuit sales will top \$3 million. Other firms, like Texas Instruments, see a more rapid growth with the major boom occurring in 1964-5. Growth rate of the market is not expected to follow the normal smooth exponential rise but will be a step function when after this 1963-4 assessment period involving quantities of a few hundred integrated circuits, the production phase from 1965 on will call for thousands, a fact that has production men worried.

Paradoxically it is the lack of a heavy military program in the U. K. that has caused this ready acceptance of commercial integrated circuit applications. With little call for the microminiaturization afforded by the circuits, reliability and economic advantages are considered their chief selling points. This emphasis is causing changes as manufacturers seek ways to recoup their development costs. In place of the original thrust on logic circuits, British designers are switching to linear circuits and hybrid systems.

LINEAR CIRCUITS—Highest priority is on linear circuit development as offering the widest market potential. All manufacturers currently offer amplifiers with gains adjustable by feedback resistor variation, solid-state demodulators, phase splitters, and emitter followers. Typical of these circuits are Plessey's single chip amplifiers (gain of 25, 6-7 Mc bandwidth).

Main applications of linear circuits are foreseen in instrumentation and sections of communications equipment. At first, hybrid configurations are an-

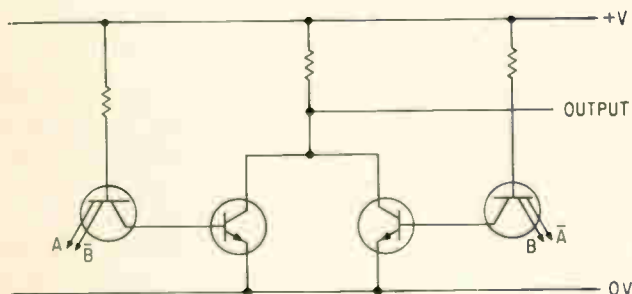


THREE VERSIONS of tape verifier designed at the British Government Research Establishment shows size reduction achieved between tube version (left), transistor and integrated circuit where all components are within the control unit—Fig. 1

anticipated using both integrated circuit elements and conventional components. But this imposes economic problems on the manufacturer since cost of linear circuit elements must be comparable to the component assembly it replaces. Cost is currently the main sales feature because integrated circuits form only a part of the overall equipment and, therefore, the increased reliability stemming from their use is limited. Solid-state costs in the U. K. are expected to be comparable with conventional techniques by 1964-5.

An alternative approach finding favor with many users is a hybrid circuit where a thin-film substrate acts as a mechanical base for the silicon integrated circuits. The economics of this approach look promising as thin-film costs are expected to be equivalent to conventional techniques by next year. With heavy Government backing British thin-film production is growing rapidly; by the end of the year it is estimated that Mullard Ltd., Welwyn Electric Co., and STC will have a joint production capacity of 30,000 thin films per week. But none of the manufacturers is saying just what the demand will be.

Solid-state logic elements—initially thought to have an immediate sales outlet—are not expected to get to full production for 2 or 3 years. Around 1967-8 the full production of electronic telephone systems, increased military applications and the commercial computer usage will push integrated circuit logic. But for the next couple of years the



EXCLUSIVE-OR integrated circuit developed at Plessey uses multiple-emitter transistors—Fig. 2

majority of clock rates for computers in production will be in the kilocycle rather than megacycle range and suppliers will find it tough going to offer solid logic with its megacycle capability at prices competitive with conventional components. In the next computer generation now on the drawing board, solid logic elements will be used. Manufacturers claim this will be within 2 or 3 years.

Another factor slowing down acceptance of solid logic is the multiplicity of logic configurations currently available on the U. K. market: DTL (Ferranti), DCTL (Texas Instruments), RCTL (Welwyn and Elliott) together with multi-emitter logic. Most likely long-term solution seems to be the multi-emitter system. One manufacturer, Plessey Ltd., is already in pilot production of a single-chip multi-emitter transistor configuration providing two-level logic. The circuit, Fig. 2, performs AND operations on the multiple-emitter transistors and an OR-INVERT in the amplifiers. Propagation time for a 40-stage parallel adder is 1 microsec.

Consumer applications in the U. K. of integrated circuits for domestic radio and tv look far out. Reasons quoted by manufacturers range from excessive costs of integrated circuits to lack of requirements for the increased reliability. Only investigation reported underway, and this rather desultorily, is the application to hearing aids.

ITALY

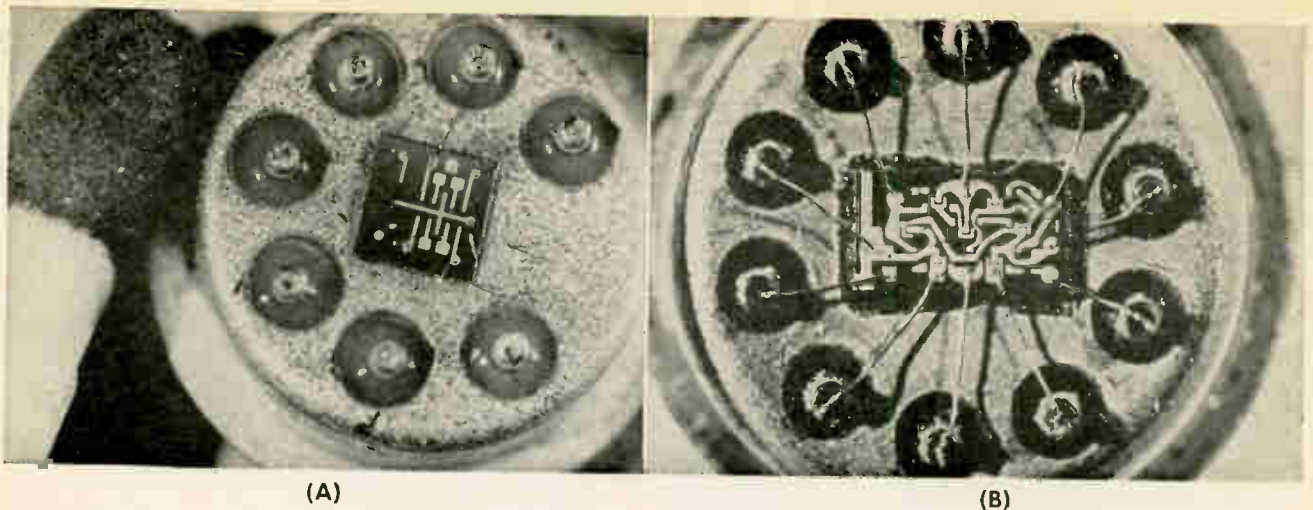
Semiconductor microcircuits planned for commercial computers, are already in some prototype office equipment

MILAN—Italy's electronics industry—both home grown and foreign affiliated—shares the opinion that a "tremendous interest" exists throughout Western Europe in applying integrated circuits to commercial computers and process control systems. But the consensus is that actual commercial application of integrated circuits in these fields in Europe—and particularly Italy (excluding some specific NATO military contracts)—is still extremely limited—particularly so when compared to integrated-circuit progress in the United States.

Major electronics firms using or studying the use of semiconductor or thin-film integrated circuits in Italy include Olivetti, IBM Italia, Cea-Perego (electronics affiliate of the giant Edison company) and the Compagnia Generale di Elettricità (CGE), Italian affiliate of the American General Electric Co.

Giorgio Sacerdotti, director of Olivetti's electronic research laboratories in Rho says Olivetti has no intention of introducing integrated circuits in its existing machines as it would not be economically sound. However, the company is studying both semiconductor and thin-film integrated circuits for commercial computers and office equipment now in development. Several prototype commercial calculators use the new systems, but he said Olivetti could not release details at the present time.

Semiconductor integrated systems rather than thin-film systems are being favored in Olivetti's planning because of the former's more widespread



MICROCIRCUITS from Siemens (A) and Telefunken (B)

use and consequent proven experience.

Industry sources suspect Olivetti will introduce its new semiconductor integrated circuit computers only when the company feels it can sell them at a profit. This may range from one to five years.

OTHER MANUFACTURERS—Cea-Perego's electronic computer expert Giorgio Quazza says his company is working on semiconductor integrated circuits for prototype computers it has under development. The firm also feels integrated circuits will have an important place in other process control devices it is developing.

Quazza says it will be one or two years before Cea Perego would consider using thin-film integrated circuits, which are still in the initial stages of development.

Enrico Chiesa, chief engineer for CGE, reports his firm is developing semiconductor circuits for eventual use in the computer and process control systems it manufactures as GE's Italian affiliate. He feels that since this type of integrated circuit has undergone more proven experience than that based on thin films, it will hold the lead over thin-film systems for at least the next few years.

Italy's largest semiconductor manufacturer Societa Generale Semiconduttori, is currently marketing Fairchild's integrated circuits. But according to SGS sales manager Donald Rogers, Fairchild plans to build its Micrologic systems in Europe by 1964 utilizing SGS's Agrate facility and another plant in London. Rogers expects dollar volume of Fairchild affiliate sales in the U. K. and Western Europe this year to run from \$1.5 million to \$2 million. He says SGS is working with about eight large computer manufacturers in Europe.

SGS plans to do some thin-film work, and Rogers feels the future of integrated circuits will be in hybrid systems utilizing a combination of semiconductor and thin-film devices.

Although SGS plans to do some work in radio circuits, Rogers believes it will be "quite some time" before component manufacturers can slash the price of their product to the low price necessary to meet the "cheap cost" demands of the radio and tv manu-

facturers. The manufacturers of these "low cost" consumer products will accept only very low-cost electronic components for their products, he says.

Among advantages cited by Rogers are lower cost resulting from less design time required to plan integrated circuit systems, fewer parts, smaller boards, and so forth. SGS estimates semiconductor integrated circuits, although they may be more expensive per individual unit, will cut costs as much as 25 percent in setting up overall electronics systems.

Siemens Elettra SpA, Italian affiliate of the West German Siemens Group, imports semiconductors from Germany where the company has been building commercial computers and process control systems since 1956, and where they are now applying semiconductor integrated circuits to these products.

Engineer Arnaldo Moruzzi says Siemens is working with semiconductors rather than thin-films, feels thin films are still "too costly, too sophisticated, too refined" to be accepted by the average Italian company.

Siemens is counting on something like \$10 million in computer sales for fiscal 1963-64 but Moruzzi emphasizes the company is still in the groundwork stage. He feels integrated circuits are an "absolute necessity" to meet the needs of advanced electronics systems. The cost is "still rather high priced," but microelectronic systems are "fulfilling high-priced functions." He adds that the cost of integrated circuits is still "far too high" for consumer items.

WEST GERMANY

Integrated circuits are under development for both industrial and consumer applications

BONN—Leading West German electronics companies are of the opinion that progress here in solid-state and thin-film integrated circuits is presently at a stage that was reached in the U. S. some two years ago. However, all of the large firms — including Siemens, Telefunken, Standard Elektrik Lorenz and Grundig—report substantial laboratory development work on integrated circuits for applications varying from computers through aerospace equipment to industrial electronics and consumer goods. Siemens

expects to use integrated circuits in the model 3003 commercial computer it is now building but will not change over its present 2002 model.

Telefunken says its offering three months ago of seven solid-state circuits for computer applications has met with gratifying success. Telefunken's progress in this sector is typical of a cautious but hopeful policy by German electronics manufacturers of developing components and finding applications in order to be prepared when the first really substantial demand occurs in three to five years' time. DCTL and ECTL circuits are out of the laboratory stage at Telefunken and available as samples for computer, data-processing, aerospace, instrumentation and military applications, where their small size and high order of dependability argue against their relatively high cost. The company says a small but technically important market already exists in Europe in the military and satellite fields.

CONSUMER APPLICATIONS—Widespread consumer goods applications cannot be expected for another five years, in the opinion of several companies whose plans include immediate market penetration in those sectors where the circuits' advantages overshadow their higher cost. Standard Elektrik Lorenz reports it is well along with laboratory testing of thin-film circuits employing tantalum (among other materials), concentrating on amplifiers, power supplies and passive circuits. The company expects to make its first deliveries in 1964, having already discussed a range of possible uses with various equipment manufacturers.

First area of application should be in data processing equipment, although SEL says it is concentrating just as heavily on tv, radio and tape recorders. Although it is still too early to give even an approximate estimate of the market for such circuits, SEL engineers feel acceptance will be rapid once the first deliveries are on the market in consumer goods. Primary advantages for integrated circuits, in their opinion, is cost-cutting of mass-produced goods and increased dependability.

Grundig says its research labs are actively pursuing integrated circuit applications in both consumer goods as well as industrial equipment. The company's primary interest lies in items such as integrating apparatus, closed circuit tv cameras—where the present tendency is to smaller dimensions—and various types of office equipment (Grundig owns the Olympia company, one of West Germany's largest office machine manufacturers).

Grundig reports that all its development work at present is intended for application in its current product line (radios, tv sets, tape recorders). Management emphasizes they are only in a research phase and that application of developments is still far off. Circuits in development are not being discussed.

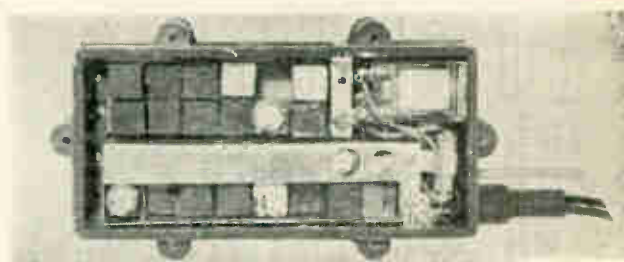
JAPAN

Microcircuits planned for telephone switching equipment and several consumer products

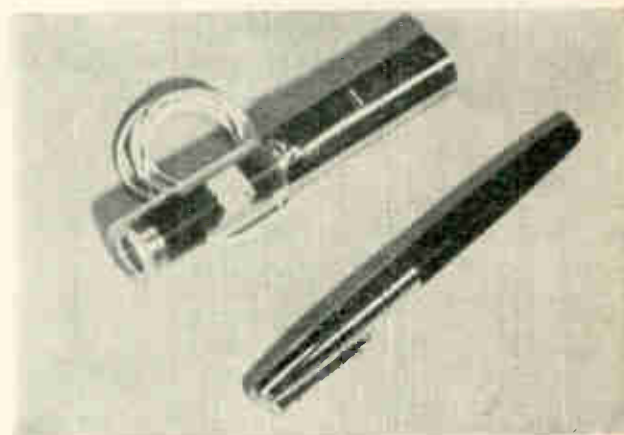
TOKYO—All Japanese semiconductor companies are studying integrated circuits, but most seem to be



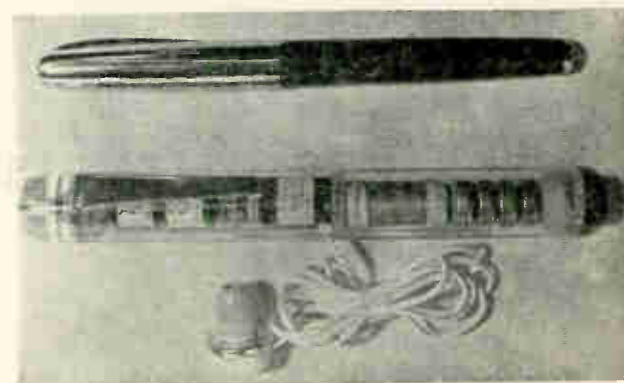
(A)



(B)



(C)



(D)

PROTOTYPES OF consumer items in which Yaou Electric plans to use integrated circuits are pocket radio (A), transceiver (B), radio microphone (C) and pencil radio (D)

waiting to see what types of circuits the Americans use for what, and their success, before committing themselves. With cost still a big stumbling block most people feel use of integrated circuits in any but the most specialized products is at least three to five years away. Nevertheless, some companies are pushing ahead on prototype development.

Middlesized Yaou Electric plans to develop several consumer items such as a pocket radio, pencil radio, transeiver, car radio, radio microphone, and radio page. The company also plans to use integrated circuits for industrial items such as tv cameras and tv broadcasting equipment including camera, auxiliary amplifier and synchronizing signal generator. The consumer items will probably use silicon circuits, while thin films look most suitable for the industrial products.

Sony's chief engineer says his company is starting to think about using integrated circuits in consumer equipment but has not yet made any definite plans.

TELEPHONE EQUIPMENT—Oki Electric Industry Co. is interested in using integrated circuits in computers and telephone exchanges. It considers speed one of the greatest advantages of applying integrated circuits to computers and is therefore looking toward all-thin-film integrated circuits for this application. On the other hand, semiconductor integrated circuits are expected to provide the increased reliability and small size considered important for telephone exchanges. Electronic telephone exchanges are expected

INTEGRATED CIRCUITS IN U. S. TELEPHONE SYSTEMS?

When informed of Japanese intentions to use integrated circuits in telephone switching equipment, two U. S. firms told **ELECTRONICS** they had no similar plans at this time but were actively studying the possibility.

Electronic switching system No. 1 being installed by Bell Telephone Labs at Succasunna, N. J., is using discrete components because present cost of integrated circuits is too high, according to R. W. Ketchledge, director of Bell's electronic switching lab. However, he foresees the need for integrated circuits in the future when machines must work faster and consequently be made much smaller to reduce delay times. Integrated circuits look promising for such applications and an exploratory development program is underway in which several basic types are being evaluated, he said.

Automatic Electric Company, a subsidiary of General Telephone & Electronics, is studying the use of silicon integrated circuits in telephone switching equipment, and believes that such usage will someday be feasible. With extreme compactness not so important in commercial telephone equipment, emphasis of the study will be on the expectations of greater reliability and (ultimately) lower cost than existing circuits using discrete components

to greatly reduce present need for expensive secondary facilities.

Although it is difficult at present to foresee the size of the market, Oki is convinced the economic feasibility of producing its integrated circuits will depend on demands for its computers and telephone exchanges. At present, trial production of semiconductor circuits is underway and thin-film circuits are being researched. Future plans include developing active thin-film elements, and trial manufacture of thin-film memories.

Nippon Electric plans to apply semiconductor integrated circuits to computers, telephone exchanges, carrier terminal equipment and others. It anticipates that by 1970 half the semiconductor devices for such equipments will be replaced by integrated circuits. Silicon circuits look most likely to be used because of their reliability.

Other companies studying integrated circuits for computers include Hayakawa Electric, Matsushita Electric Industrial Co. and Mitsubishi Electric. Matsushita is researching the introduction of thin-film circuits into some commercial computers that are presently all-transistorized. Thin films are expected to appear shortly in switching circuits, later in other portions. The company reports similar plans for consumer items like transeivers and tape recorders.

Mitsubishi is experimenting with various types of circuits but considers details company secret. Hayakawa is researching thin films primarily for small computers at this time because of the present high cost.

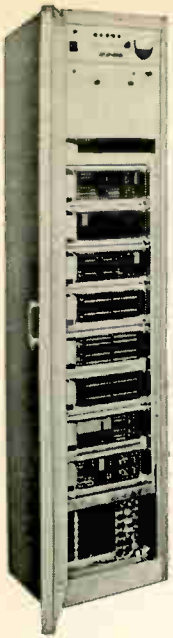
SWEDEN

Integrated circuits under close scrutiny for industrial computers

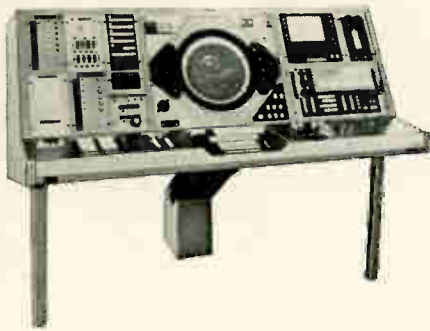
STOCKHOLM — Standard Radio & Telefon AB, Bromma, is planning to use semiconductor integrated circuits in military and industrial type computers for series production starting 1967-68. Extensive use of integrated circuits is considered dependent on the reduction of present prices that is foreseen in the near future. The requirement for the individual circuit element is fairly moderate in logic circuits and will thus promote a good yield of the production of integrated circuits in these applications, the company feels.

Svenska Aeroplan Aktiebolaget (SAAB) reports that for the past couple of years it has been working on an integrated circuit technique in designing an airborne digital computer. SAAB, most famous for its jet fighter planes and rally-winning automobiles, has an electronics division that produces computers for civil and military use.

Viggo Wentzel, head of the computer department, says that as a result of this integrated circuit work "we have gained a lot of experience and we also feel that we have been successful in using integrated circuits for that particular project. Having this background it is quite natural that we are now studying the integrated circuit technology in order to find out if, and when, we can use this technology in our future commercial computers. From the same point of view, we are also interested in thin-film



CENTRAL DIGITAL COMPUTER and system control desk is type of equipment in which Sweden's Standard Radio & Telefon plans to use integrated circuits



circuits or possibly in hybrids. The latter may be a more optimum technique at this time. As a consequence of our interest in this circuit technology, we have now started suitable evaluation work on the matter."

Wentzel adds that the basic advantage SAAB foresees for integrated circuits in commercial digital computer applications lies in increased reliability. He also says that during SAAB's early work with integrated circuits, they found that the assembly cost will be considerably reduced when the prices of integrated circuits "come down to a reasonable level."

"We have also found that layout and draft work was eased because the integrated technique allowed a more standardized logical symbolism," Wentzel says.

Speaking for L. M. Ericsson Co., the telecommunications firm, Percy Broomé says that his company has not introduced integrated circuits into any equipment manufactured by the firm "and we have no decisive plan to do so." He adds, however that the company is keeping abreast of developments in this field and has discussed the possibilities of using integrated circuits in certain control units in airborne equipment. This would be the first step in a coming chain of introducing integrated circuits in airborne and later on in ground equipment, both for military and civil purposes, Broomé says.

FRANCE

Major market is still military

PARIS—France seems to be an exception to the foregoing industrial electronics picture. Although all the heavyweights of the French electronics industry see high promise for integrated circuits, no one is far enough along with them to talk specifics about the potential commercial market.

True, by the end of the year the semiconductor manufacturing subsidiaries of CSF, Thomson-Hous-

ton and Philips all will have pilot production lines started up, or just about ready to start, but for the next two or three years only military applications seem likely. In fact, French Air Force research funds have financed the bulk of integrated-circuit R&D done so far.

The computer makers, too, are taking a hard look at these circuits. Bull, for example, says it's cooperating closely with component manufacturers to develop planar silicon circuits, and is working on superconducting thin films in its own laboratories. A top research engineer at Bull predicts a mass entry of integrated circuits in the computer field within the next five years, but refuses to be more specific than that.

At IBM-France, integrated circuits rate as just one of several avant-garde techniques that may one day cut down the cost of computers. At its La Gaude research center, for example, thin-film parametric cells are under development. They have relatively slow switching times but exceptional cost-cutting potential. However, IBM-France's research chief flatly states there's no prototype computer in the works for the moment.

SILICON DOMINATES—A look at the pilot-production units slated to go on the market next year shows the silicon integrated circuit dominating. CSF's subsidiary COSEM is setting up a line to produce logic circuits by the planar technique. And CSF has developed an experimental NOR circuit with four field-effect transistors plus passive components diffused into a silicon slab 1 mm by 1.5 mm. Still, a CSF engineer working on integrated-circuit research thinks that for the long haul the hybrid circuit shows the greatest promise because you can't get very high resistance and capacitance values in a silicon slab.

At SESCO (Societe Europeenne des Semi-conducteurs), the Thomson-Houston semiconductor subsidiary, silicon integrated circuits will start coming off a pilot production line early in 1964. The circuits and the technique used to produce them are very similar to General Electric's—SESCO will begin production using GE masks.

Still a third company, the Philips group subsidiary COPRIM (Compagnie des Produits Elementaires pour Industries Modernes) recently put on the market preproduction prototypes of hybrid integrated logic circuits using oxide films on a glass base for the passive elements. Like CSF and SESCO, COPRIM sees only military applications—notably airborne computers—in sight for the moment.

With military computer applications the only imminent potential market, French integrated-circuit manufacturers generally cite reliability first and component density second when talking about the advantages of integrated circuits. And all three agree that computers look far and away the most likely commercial application, but not until the price is right.

As far as consumer items go, the French feel that integrated circuits won't start to find their way into radio and tv sets until they're cheaper than conventional circuits. Right now, that seems several years off.

Sequence Pulse Generator

Simplified generator produces many outputs from one input without objectionable interaction. Only one power supply is required

By A. S. OTTENSTEIN and R. L. PAUL Seaboard Electronic Corp., New York, N. Y.

THIS CIRCUIT provides five independent gating outputs when triggered by a single pulse. It is useful in many digital control systems that require sequential timing and gating pulses. It uses about half the number of transistors in a conventional monostable configuration and can be designed to provide as many as ten outputs.

The circuit has been used successfully in several digital systems. Accuracy and stability were identical to individual pulse-forming circuits in the range -55°C to 71°C .

OPERATION—In Fig. 1A, switching transistor Q_6 is normally in the OFF state while output transistors Q_1 through Q_5 are ON. Application of a positive trigger pulse to the input turns OFF Q_6 and turns ON Q_5 through feedback network R_{11} and C_{11} . The resulting positive-step voltage is applied to output transistors Q_1 through Q_5 . Each of these transistors has an independent network connected to its base to determine the OFF time; thus, the pulse width of each output is determined by these time constants. No interdependence exists except in the network formed by R_5 and C_5 , which must be used to produce the output gate of maximum width.

DESIGN—The equations developed in reference 1

are used in the design. It is assumed that similar transistors with equal base and collector currents are used so that all base resistors are equal and all collector resistors are of the same value.

For Q_1 through Q_5

$$I_C = \frac{V_1 - V_{CE(\text{sat})}}{R_C} \quad (1)$$

To insure saturation

$$I_{B(\text{min})} \geq \frac{I_C}{h_{FE(\text{min})}} \quad (2)$$

To insure temperature stability

$$I_{B(\text{min})} \geq 8 I_{CBO(\text{max})} \quad (3)$$

To insure proper base drive

$$R \leq \frac{V_1 - V_{BE(\text{sat})}}{I_{B(\text{min})}} \quad (4)$$

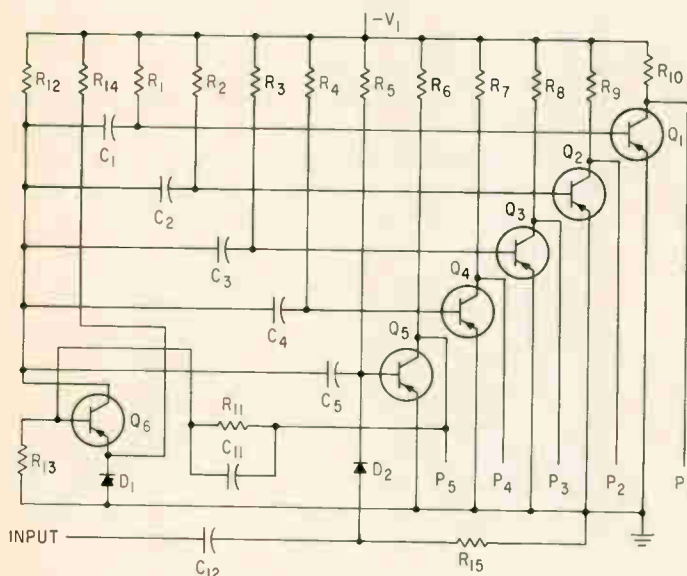
If $V_{BE(\text{sat})}$ is small with respect to V_1 , the output pulse width is

$$T = 0.69 RC$$

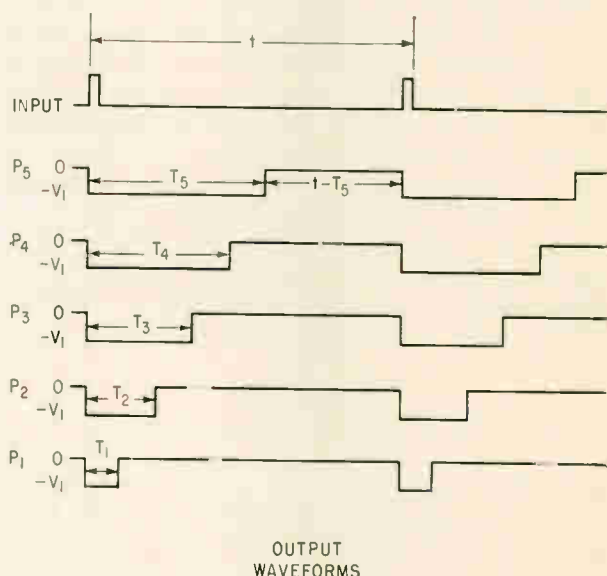
from which

$$C = \frac{T}{0.69 R} \quad (5)$$

To insure that the capacitors fully charge during the circuit recovery time ($t - T_c$), the following restriction is placed on R_{10} .



$$R_1 = R_2 = R_3 = R_4 = R_5 = R \quad R_6 = R_7 = R_8 = R_9 = R_{10} = R_C \quad (A)$$



(B)

PULSE generator has five outputs, but more can be obtained (A). Time constants in base circuits determine T_1 to T_5 . Last stage must have longest duration (B)—Fig. 1

Saves Transistors

$$\text{where } 5 R_{12} [C_1 + C_2 + C_3 + C_4 + C_5] \leq (t - T_n) \\ T_n = R_5 C_5$$

$$\text{or } R_{12} \leq \frac{(t - T_n)}{5 C_{\text{total}}} \quad (6)$$

The peak collector current of Q_6 is,

$$I_{C6} (\text{peak}) = \frac{V_1 - (V_{CE6} + V_{E6})}{R_{12}} + \frac{2V_1 - (V_{BE} (\text{sat}) + V_{E6} + V_{CE6})}{5 R} \quad (7)$$

To insure saturation of Q_6 a base current must be supplied which is,

$$I_{B6} (\text{min}) \geq \frac{I_{C6} (\text{peak})}{h_{FE6} (\text{min})} \quad (8)$$

Virtually independent outputs are achieved only when a low impedance is present at the collector of Q_6 when it is ON. This low impedance is assured only if Q_6 remains saturated.

The OFF bias is provided at the emitter of Q_6 through the combined action of resistor R_{11} and diode D_1 . High conductance diodes must be employed if I_{C6} peak is large.

DESIGN EXAMPLE—Transistors Q_1 through Q_5

Type	— 2N404
I_C	= 10 ma, $h_{FE} (\text{min}) = 15$
$V_{CE} (\text{sat})$	= 0.1 v
$V_{BE} (\text{sat})$	= 0.15 v
$I_{CBO} (\text{max})$	= 0.1 ma

Let $T_1 = 20$ ms, $T_2 = 40$ ms, $T_3 = 60$ ms, $T_4 = 80$ ms, $T_5 = 100$ ms Input rep rate = 6 cps. (Fig. 1B).

Transistor $Q_6 = 2N1187$

$h_{FE} (\text{min})$	= 40
$V_{CE} (\text{sat})$	= 0.2 v
$V_{BE} (\text{sat})$	= 0.5 v
$I_{CBO} (\text{max})$	= 0.120 ma
V_{E6}^0	= 0.6 v
V_1	= 12 v

From Eq. 1

$$R_C = \frac{12 - 0.1}{1 \times 10^{-3}} = 1,190 \text{ ohms} \quad \text{Use } R_C = 1,200 \text{ ohms}$$

From Eq. 2 and 3

$$I_B \geq \frac{10 \times 10^{-3}}{15} = 0.66 \text{ ma}$$

$$I_B \geq 8 (0.1 \times 10^{-3}) = 0.8 \text{ ma}$$

$$\text{From Eq. 4 } R \leq \frac{12 - 0.15}{0.8 \times 10^{-3}} = 15,000 \text{ ohms}$$

$$\text{From Eq. 5 } C_5 = \frac{100 \times 10^{-3}}{0.69 (15 \times 10^{-3})} = 10 \mu f$$

Solving for the other capacitor values

$$C_1 = 2 \mu f, C_2 = 4 \mu f, C_3 = 6 \mu f, C_4 = 8 \mu f$$

$$\text{From Eq. 6 } R_{12} \leq \frac{50 \times 10^{-3}}{150 \times 10^{-6}} = 330 \text{ ohms}$$

$$\text{From Eq. 7 } I_{C6} (\text{peak}) = \frac{12 - (0.2 + 0.6)}{330} + \frac{24 - (0.15 + 0.6 + 0.2)}{3 \times 10^3} \\ = 41.6 \text{ ma}$$

$$\text{From Eq. 8 and 3 } I_{B6} \geq \frac{41.6 \times 10^{-3}}{40} = 1.04 \text{ ma}$$

$$I_{B6} \geq 8 (120 \times 10^{-6}) = 0.96 \text{ ma}$$

use $I_{B6} = 1.04$ ma

For good temperature stability I_{R13} is made equal to $3 I_{CBO(\text{max})}$ during the ON state of

$$R_{13} = \frac{V_{BE6} (\text{sat}) + V_E}{3 I_{CBO6}} = \frac{0.5 + 0.6}{360 \times 10^{-6}} = 3,050 \text{ ohms}$$

use $R_{13} = 3,000$ ohms

To insure adequate base drive when Q_6 turns ON, the current through R_{11} is made equal to $I_B (I_{R13})$. Therefore

$$R_{11} + R_6 = \frac{V_1 - (V_{BE} (\text{sat}) + V_E)}{I_{B6} + 3 I_{CBO6}} \\ = \frac{12 - (0.5 + 0.6)}{(1.04 + 0.36) \times 10^{-3}} = 7,800 \text{ ohms}$$

However, since $R_6 = 1,200$ ohms, $R_{11} = 6,600$ ohms. Use $R_{11} = 6,200$ ohms.

In the OFF state, the voltage at the base of Q_6 is 0.3 volt with 0.120 of leakage. This, in conjunction with the 0.6 volt developed across D_1 , provides an OFF bias of 0.3 volt at 71 C.

APPLICATIONS—One application is a multiple-channel temperature alarm system. This system consists of a 5-shot sequence generator with two fixed outputs, one to accomplish operation *T logic* and one to establish a time reference *T ref*, an external clock. The three remaining channel-timing resistors can be replaced by thermistors. These temperature-sensing elements will be mounted so as to monitor three critical temperature points in a system. To accomplish system sampling, a clock with known frequencies triggers the generator. The outputs of T_1 , T_2 and T_3 are fed to three a-c gates that will sample the positive-going trailing edges of the monitoring channels. The gates are open only during the period of *T ref*. During a nonalarm condition, the period of each monitoring channel is selected to be greater than *T ref* but shorter than *T logic*. If the temperature on any one channel or on all channels increases to an alarm condition, the period of time generated by that channel will decrease until its trailing edge falls within the period of *T ref*. The pulse will pass through the gate, be integrated and trigger the alarm circuit.

Since the system clock rate is fixed and the period of each monitoring channel is a function of temperature, these may be individually sampled with a dwell meter calibrated to indicate temperature. After receiving an alarm condition, the operator is able to sample the temperature of the individual channels and determine the exact point in the system where fault occurred

REFERENCE

(1) R. L. Paul and A. Ottenstein, Eliminating the First Stage Of A Monostable Multivibrator. *ELECTRONICS*, Sept. 7, 1962.

Designing Input Circuits

Getting lowest possible noise means juggling input transistor types, source and impedance levels, and other factors. Field-effect transistors, for example, come into their own when source impedance levels are high

By JOHN J. RADO, Precision Instrument Co., Palo Alto, California

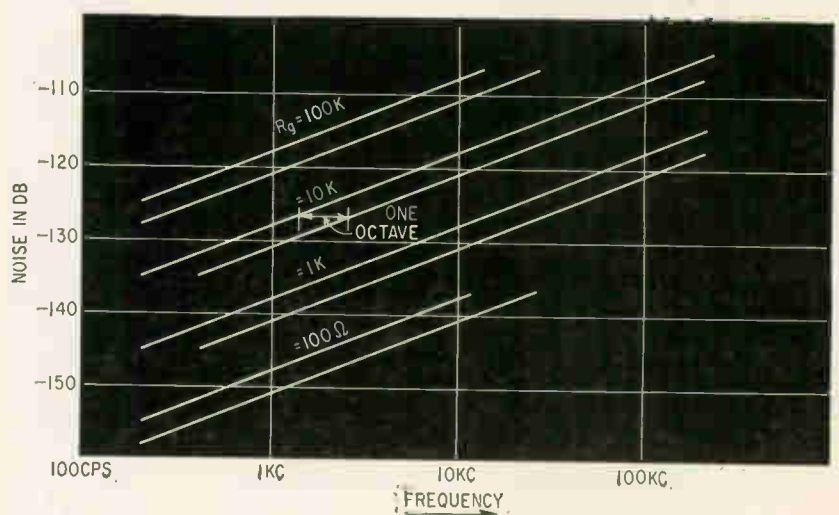
SYMBOLS FOR THE EQUATIONS — TABLE I

Symbols for the Equations — Table I

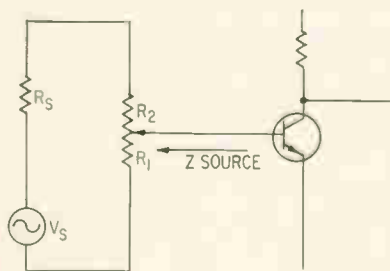
V_{CE}	— Collector to emitter voltage
I_c	— Collector current
R_g	— Generator or source resistance
NF	— Noise Figure
$S_{P in}$	— Signal power input
$S_{P out}$	— Signal power output
$N_{P in}$	— Noise power input
$N_{P out}$	— Noise power output
$S_{V in}$	— Signal voltage input
$S_{V out}$	— Signal voltage output
$N_{V in}$	— Noise voltage input
$N_{V out}$	— Noise voltage output
N_{VD}	— Noise voltage of input device (transistor)
A	— Open loop gain
Δf	— Bandwidth
f	— Frequency
$f\alpha$	— Cutoff frequency
h_{FE}	— Current Gain
B	— Feedback ratio
e_{out}	— Output voltage (amplifier)
e_{in}	— Input voltage (amplifier)
R_E	— Emitter resistance
$Z'_{in ol}$	— Open loop input impedance (without bias network)
$Z'_{in cl}$	— Closed loop input impedance (without bias network)
$Z_{in cl}$	— Closed loop input (with bias network)
$Z_{cl out}$	— Closed loop output

ART IN ENGINEERING

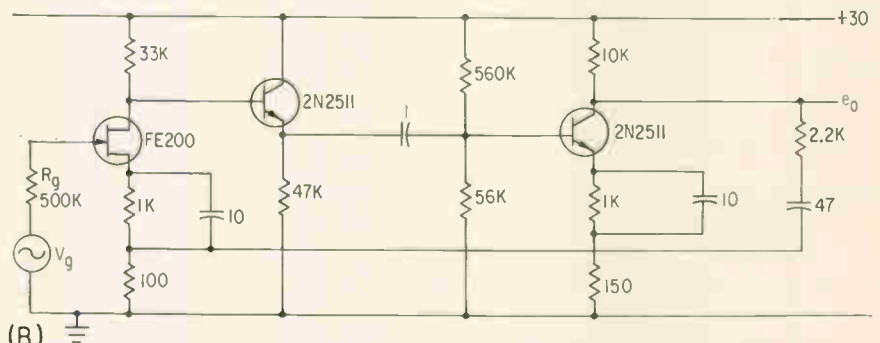
Until all amplifier design is completely analyzed and computer programmed, the circuit designer will have to do some blind flying. Call it the art of engineering. Rules like keeping source impedance low to minimize noise and pickup are vital, but sometimes basic rules have exceptions. Even if amplifier design could be done by computer, there would still be times when it might be simpler to do it yourself



PARALLEL LINES define one-octave bandwidths for various source impedances. Increasing bandwidth increases noise by 3 db for each octave—Fig. 1



(A)



(B)

LOWEST INPUT impedance is not always optimum for lowest noise operation (A). The field-effect input transistor (B) will give lower noise than the more usual types when source impedance is high—Fig. 2

With Lowest Possible Noise

NOISE in transistor amplifiers originates from three basic factors: internal noise generated by the components of the amplifier; noise generated by the source; and the bandwidth of the amplifier and its relation to the bandwidth of the noise.

The designer has at least a limited control in selecting components with low-noise characteristics and in setting circuit parameters to enhance operation. Source and the amplifier bandwidth are usually either given or implied in the specification and therefore can seldom be altered to improve the noise figure of the amplifier.

INPUT TRANSISTOR NOISE—

The equivalent input noise of any amplifier cannot be less than the noise contributed by the input stage. Noise generated by subsequent stages will be, in essence, reduced by the gain preceding them. The manufacturer's data sheet for the 2N930, a popular unit for low-level low-noise applications, shows, for example, a noise figure (*NF*) of 4 db max for $V_{CE} = 5$ v, $I_c = 10$ μ a, and $R_s = 10,000$ ohms for a bandwidth from 10 cps to 10 Kc. (See Table I for symbols.)

What is the best performance possible with this type of transistor? Will it be possible, for example, to recover a 10 μ v signal with less than 1 μ v noise superimposed?

Noise figure is defined as

$$NF = 10 \log \left(\frac{S_{P_{in}}/N_{P_{in}}}{S_{P_{out}}/N_{P_{out}}} \right)$$

Since both signal and noise voltages look into the same generator resistance

$$S_{P_{in}} = S_{V_{in}}^2/R_s \quad \text{and} \quad N_{P_{in}} = N_{V_{in}}^2/R_s$$

$$NF = 10 \log \left(\frac{S_{V_{in}}/N_{V_{in}}}{S_{V_{out}}/N_{V_{out}}} \right)^2$$

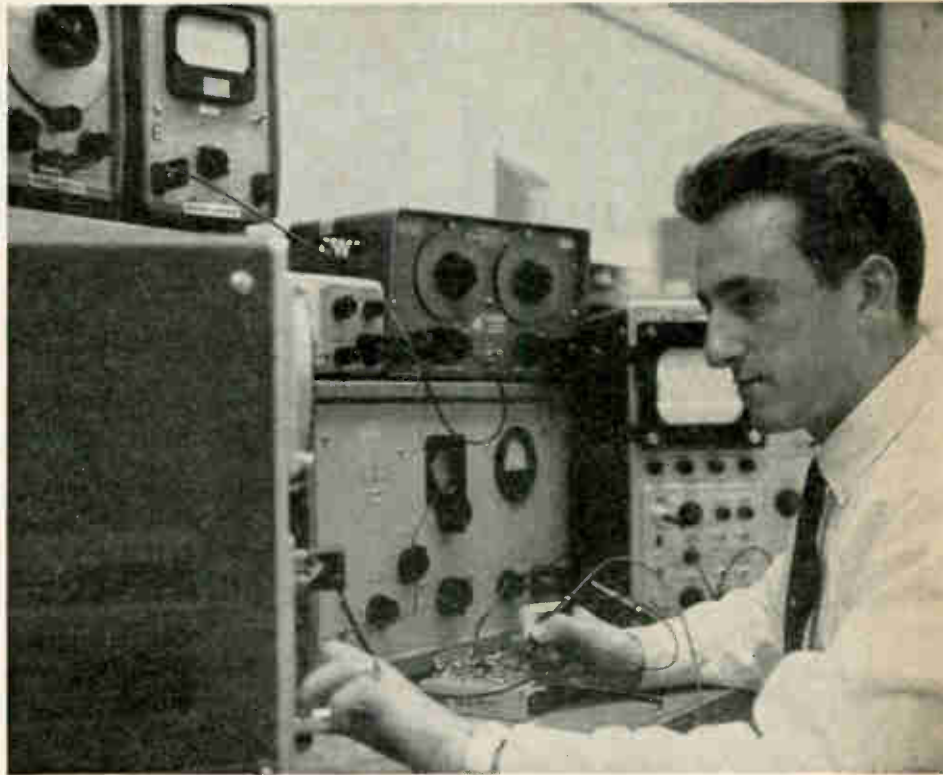
$$= 20 \log \left(\frac{S_{V_{in}}/N_{V_{in}}}{S_{V_{out}}/N_{V_{out}}} \right) \quad (1)$$

If the amplifier voltage gain is *A*, then

$$S_{V_{in}}/S_{V_{out}} = 1/A \quad (2)$$

$$\text{and} \quad N_{V_{out}} = A(N_{V_{in}} + N_{VD}) \quad (3)$$

where N_{VD} is the noise voltage of



WIDEBAND AMPLIFIER is optimized for low noise with respect to both source impedance and input transistor

the input device. Rearranging Eq. 1 and substituting Eq. 2 and 3

$$NF = 20 \log \frac{S_{V_{in}}/N_{V_{in}}}{S_{V_{out}}/N_{V_{out}}}$$

$$= 20 \log \frac{S_{V_{in}} \cdot N_{V_{out}}}{S_{V_{out}} \cdot N_{V_{in}}}$$

$$= 20 \log \frac{S_{V_{in}}}{S_{V_{out}}} \cdot \frac{A(N_{V_{in}} + N_{VD})}{N_{V_{in}}}$$

$$= 20 \log \frac{1}{A} \cdot \frac{A(N_{V_{in}} + N_{VD})}{N_{V_{in}}}$$

$$NF = 20 \log \left(1 + \frac{N_{VD}}{N_{V_{in}}} \right) \quad (4)$$

Assuming input noise $N_{V_{in}}$ is entirely thermal noise generated in source resistance R_s

NOISE FOR A BANDWIDTH FROM 100 CPS TO 200 KC FOR VARIOUS SOURCE IMPEDANCES—TABLE II

R_s in ohms	Noise in db
10,000	-105
1,000	-115
100	-125
10	-135
1	-145

$$N_{V_{in}}^2 = 4 \cdot K \cdot T \cdot \Delta f \cdot R_s \quad (5)$$

where *K* = Boltzmann's constant.

For $\Delta f = 10$ Kc, $R_s = 10,000$ ohms (both as specified in the 2N930 data sheet), and $T = 273 + 20 = 293$, input noise $N_{V_{in}}$ is ($K = 1.38 \times 10^{-23}$ joule/deg K) easily calculated as 1.27 microvolts, which is the noise generated by the generator resistance alone.

Substituting this value into Eq. 4 and solving for N_{VD} for $NF = 4$ db (as specified for the 2N930)

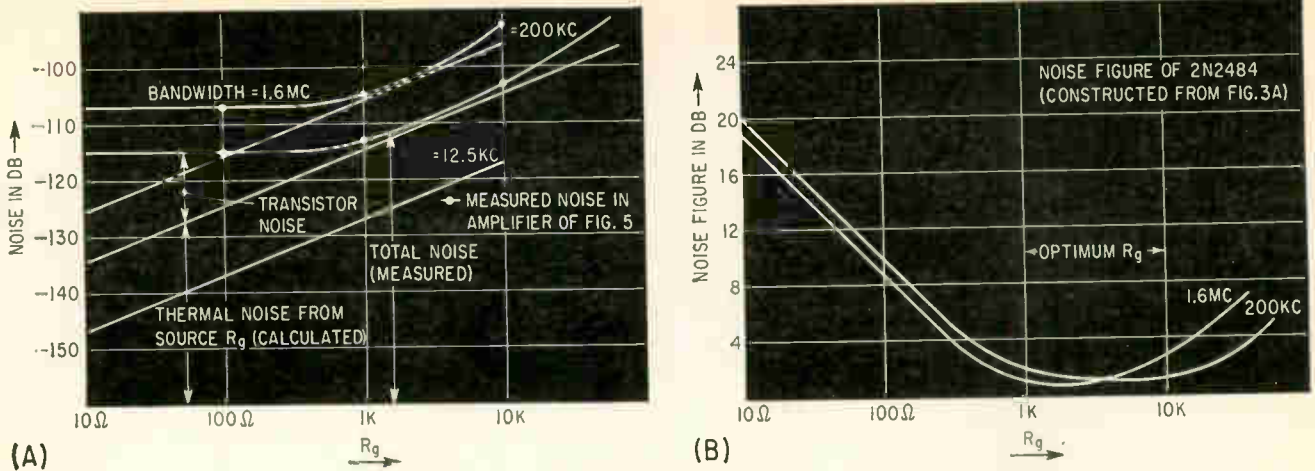
$$\frac{4}{20} = \log \left(\frac{1.27 \times 10^{-6} + N_{VD}}{1.27 \times 10^{-6}} \right)$$

$$N_{VD} = 0.74 \mu\text{v}$$

Thus, thermal noise from the input transistor amounts to 2.01 μ v, of which 0.74 μ v is contributed by the transistor. This is the minimum noise at the input for the conditions given.

Noise factors are summarized in Fig. 1 and Table II.

SOURCE IMPEDANCE—Contrary to intuition, lower source imped-



WIDEBAND NOISE as a function of source impedance (A) and optimum source impedance (B)—Fig. 3

ance does not necessarily mean lower transistor noise figure. To verify this, assume the hypothetical case represented in Fig. 2A.

The circuit is a good analogy for transducer inputs such as the reproduce head of a tape recorder or the pick-off windings of a differential transformer. Since both of these devices operate by electromagnetic induction, their output voltage will, to a first approximation, follow the $e = N d\phi/dt$ relationship. In other words, the output voltage will increase with the number of turns but so will the source impedance to the input transistor.

Thus there is a source impedance that will yield maximum output voltage and minimum transistor noise figure. In other words, a compromise has to be worked out between transducer output impedance, output voltage and transistor noise figure.

For applications where the pre-amplifier is to operate from a source impedance of several hundred kilohms, field-effect transistors may provide the best overall signal-to-noise ratio. The extremely high input impedance (several megohms and thus minimum loading effect on the source) and minimum noise figure for a source impedance from 100,000 ohms to 1 megohm for field-effect devices produces this result.

The FET 200 field-effect transistor used as input device in the amplifier of Fig. 2B has a noise figure of about 1 db, or an order of magnitude better than any of the low-noise transistors (2N930,

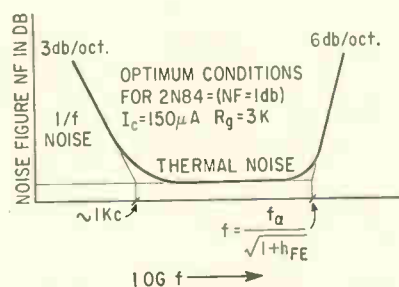
2N2484) for the same source impedance.

For most transistors, optimum noise figure will occur if the generator resistance is between 1,000 and 10,000 ohms. For source impedances from 500,000 ohms to 1 megohm, field-effect transistors will show better performance.

Figure 3A shows noise figures for the 2N2484 as a function of source impedance for two bandwidths; Fig. 3B shows optimum source impedance.

COLLECTOR CURRENT AND BANDWIDTH—In the preceding analysis of the effect of source impedance on the noise figure of a transistor, collector current was assumed constant and both measurements and calculations were made at a few exclusive frequencies and bandwidths.

But the noise figure also depends on collector current and bandwidth; these also effect one another and their combination further effects the optimum source impedance. Despite this combination of variables some relatively simple rules



TRANSISTOR noise has two break points—Fig. 4

indicate the general trend caused by each variable individually and can aid optimization. Noise figure as a function of frequency is plotted in Fig. 4. At low frequency is the $1/f$ or flicker noise region, which reaches a minimum at around 1 Kc.

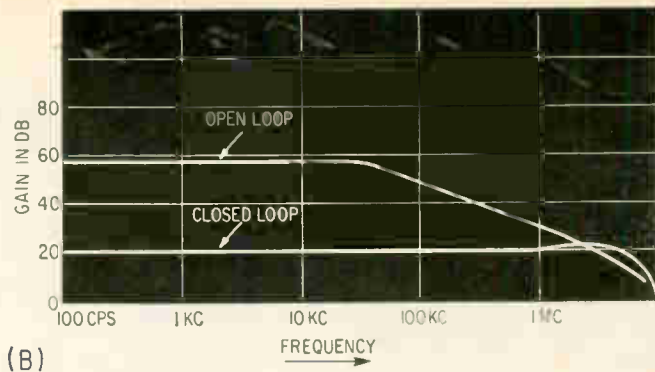
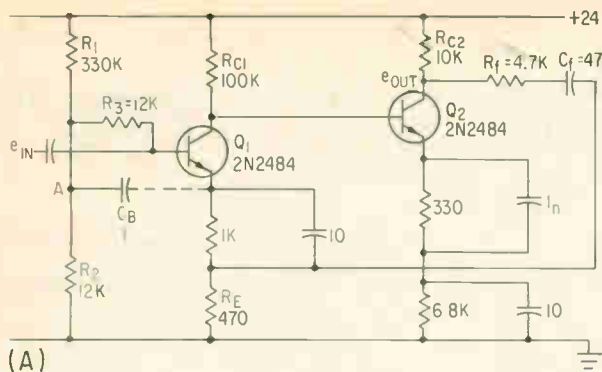
Noise figure remains constant until the second breakover point occurs at $f = f_o/\sqrt{1+h_{FE}}$, after which it increases at 6 db per octave.

Since the high-frequency performance of a transistor improves with increasing collector current, the second breakover point also occurs at higher frequencies. In general, increased collector current moves the curve in Fig. 4 up and to the right; the optimum source impedance is inversely proportional to bandwidth (Fig. 3B). In addition, higher collector current requires lower source impedance to obtain the same noise figure.

The noise figure of field-effect transistors, however, does not change with drain current (corresponding to I_c) and the first breakover point, the end of the $1/f$ region, occurs about one magnitude lower than that indicated in Fig. 4, which makes them particularly suitable for low-noise high-input impedance applications from d-c to 1 Kc.

WIDEBAND AMPLIFIER—A low-level, low-noise wideband amplifier was designed along the lines set forth above.

The Fairchild 2N2484 double-diffused silicon planar transistor was selected for the amplifier. Its noise figure is shown in Fig. 3. The



LOW-NOISE, wideband amplifier (A), designed for tape recorder, and its responses (B)—Fig. 5

Amelco 2N2511 transistor was found to have identical characteristics and is, therefore, interchangeable with the 2N2484.

The completed circuit is given in Fig. 5A. Since the amplifier is used as head preamp in the reproduce circuit of a tape recorder, the actual effective source impedance varies from 1,000 to 6,000 ohms with frequency. As indicated in Fig. 4, optimum collector current is $I_c = 150 \mu a$ for this range of source impedance.

Since the gain of the first stage is in excess of 12 to 15 db throughout the bandwidth of interest, a 10,000 ohm collector resistor was permissible. Although this 10,000 ohms also appears as source impedance for the second stage, which from the standpoint of noise is not ideal, its effect on overall noise is negligible due to the gain preceding it. It further permits direct coupling between stages. Overall open-loop and closed loop gains are shown in Fig. 5B.

The feedback used increases the open-loop input impedance and decreases the open-loop output impedance in proportion to the available excess gain. A good approximation for low frequencies can be developed by starting with the expression for a feedback amplifier

$$\frac{e_{out}}{e_{in}} = \frac{A}{1 + A \cdot B} \quad (6)$$

Product $A \cdot B$ is sometimes called the excess gain. In the amplifier of Fig. 5A, $A \cdot B$ amounts to approximately 36 db or a factor of 63. Open loop input impedance is

$$Z'_{in(ol)} \approx R_e \cdot h_{FE} \quad (7)$$

after closing the loop it is

$$Z'_{in(cl)} \approx R_e \cdot h_{FE} \cdot A \cdot B \quad (8)$$

This impedance, however, is fur-

ther reduced by the bias network R_1 , R_2 , and R_3

$$R_{bias} = \frac{R_1 R_2}{R_1 + R_2} + R_3 \quad (9)$$

Then

$$Z'_{in(cl)} = \frac{\frac{R_1 \cdot R_2}{R_1 + R_2} + R_3 \cdot R_e \cdot h_{FE} \cdot A \cdot B}{\frac{R_1 \cdot R_2}{R_1 + R_2} + R_3 + R_e \cdot h_{FE} \cdot A \cdot B} \quad (10)$$

Considering the circuit values used in Fig. 5, the conclusion is, that since $Z'_{in(cl)}$ is at least two magnitudes larger than R_{bias} , maximum input impedance at best will be of the order of R_{bias} .

Since the source impedance (the reproduce head) feeding the amplifier increases with frequency, the loading effect also becomes more and more significant. Using the parameters shown in Fig. 5, and considering a source impedance of 6,000 ohms, perhaps 20 percent of the available signal (6,000 ohms looking into 24,000 ohms) is lost.

To avoid such loading effect, bootstrapping was considered. By returning point A with capacitor C_f to the emitter of Q_1 , the shunting effect of R_{bias} is, in essence, swamped out and the source, with increasing frequency sees $Z'_{in(ol)} \approx R_e \cdot h_{FE} \cdot A \cdot B$.

But as the frequency goes above 10 Kc, the approximation of Eq. 10 loses validity. The effect of the collector capacitance (thus far neglected) will become significant, appearing as a shunt across $Z'_{in(ol)}$. This, in addition to the fact that both h_{FE} and A decrease with increasing frequency, is responsible for the shape of impedance curves of Fig. 6A and 6B.

OUTPUT IMPEDANCE—Output impedance of the amplifier of Fig. 5 can be calculated as follows. The open loop output impedance is R_{out} in parallel with $R_f + j\omega C_f$. Closed loop output impedance is

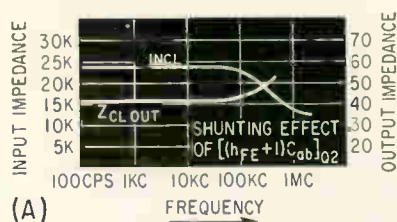
$$Z_{out} \approx \frac{R_{c2}(R_f + j\omega C_f + R_E)}{R_{c2} + R_f + j\omega C_f + R_E} \cdot \frac{1}{A \cdot B} \quad (11)$$

The wideband noise of the amplifier is shown in Fig. 3A. The noise in octaves within a 200 Kc bandwidth is given in Fig. 6C.

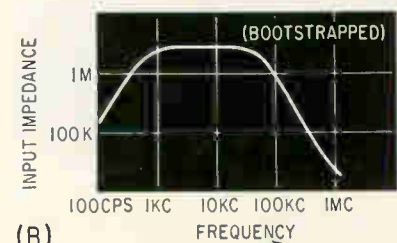
No attempt has been made here to cover all theoretical aspects of noise or to follow a bona fide analysis of the equivalent circuits of the amplifier of Fig. 5. The general standpoint has been practical. The concept was to provide some general rules and approximations that will help improve circuit performance.

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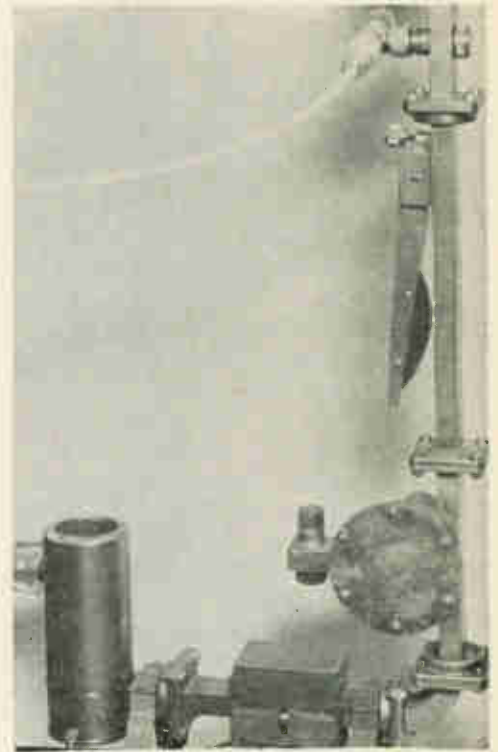
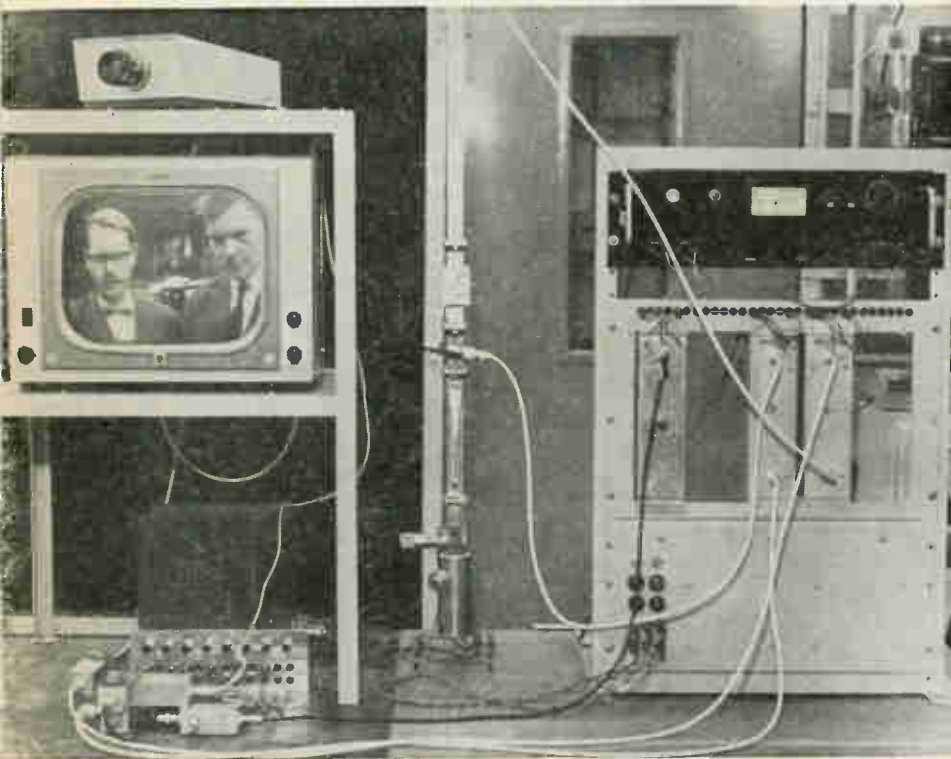
(A)



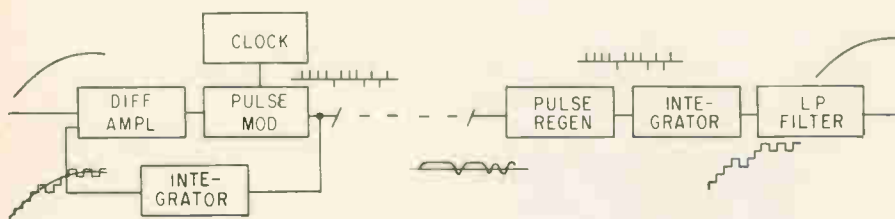
(B)

INPUT and output impedance (A) of amplifier shown in Fig. 5 and the effects of bootstrapping (B)—Fig. 6

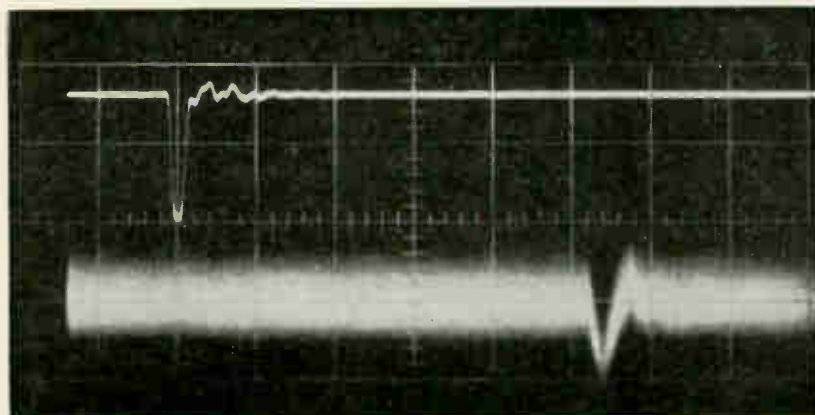
Delta Modulator Codes



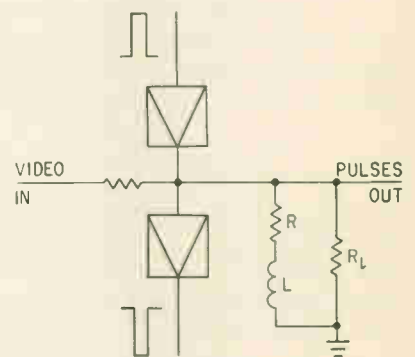
AUTHORS' pictures are transmitted over the closed circuit (left). Detail of crystal modulator (insert at right) showing crystal diode crossing waveguide to increase bandwidth above that available with crystal in shunt arm



DELTA modulator uses feedback, quantized in amplitude and time, to obtain a faithful replica of the transmitted signal—Fig. 1



FIVE-NANOSECOND pulse before and after transmission through 3-cm waveguide circuit showing delay and distortion in waveguide



TUNNEL-diode Goto pair achieves high speed in simple delta-modulator—Fig. 2

Television Waveguide Link

*Clock rate of 100 Mc is the key to high-quality transmission over simulated
25 Km waveguide with a simple tunnel-diode Goto pair*

By C. KRAMER and J. C. BALDER Philips Research Laboratories
N. V. Philips' Gloelampenfabrieken Eindhoven, Netherlands

WHY IS IT BETTER?

The trick here is to provide a simple system suitable for long-distance transmission of a high-quality television picture over waveguide. The design considers a signal of 5-Mc bandwidth to be sent 25 kilometers. Delta modulation, a form of pulse code modulation, is chosen. Tunnel diodes operating at clock rates of 100 Mc make for simple hardware while also keeping the ratio of signal-to-quantizing noise—this noise decreases as a function of clock frequency—to about 40 db

DELTA-MODULATION^{1, 2} converts a continuous signal into a binary pulse pattern for transmission through low-quality channels. The conversion is effected by quantized feedback, as shown in Fig. 1.

The pulse modulator produces a positive or a negative pulse, depending on the polarity of the difference between the input signal and a reconstructed signal obtained by integrating the pulses. The reconstructed signal is thus made to approximate the original signal as closely as possible. At the receiver the pulses must be integrated to obtain the same reconstructed signal, after which the high-frequency components are removed by a low-pass filter. The difference between the input signal and the filtered reconstructed signal gives rise to quantizing noise, which decreases

with increasing clock frequency.

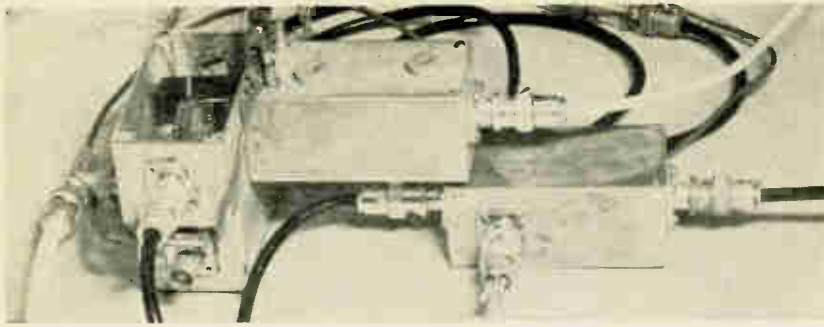
To transmit a tv signal of 5-Mc bandwidth with a signal-to-quantizing noise ratio of 40 db, a clock rate of 100 Mc is required. An extremely simple delta-modulator³ that operates at these high clock rates can be constructed by using tunnel diodes, Fig. 2.

This circuit can be shown equivalent to the encoder in Fig. 1. The difference of the original video signal current and the reconstructed signal current flows either into or out of the node between the tunnel diodes and gives rise to either a positive or a negative voltage pulse. The reconstructed signal is obtained by integrating the output voltage pulses in the network comprising inductance L and series resistance R_s . The current steps built-up in the integrator counteract the signal

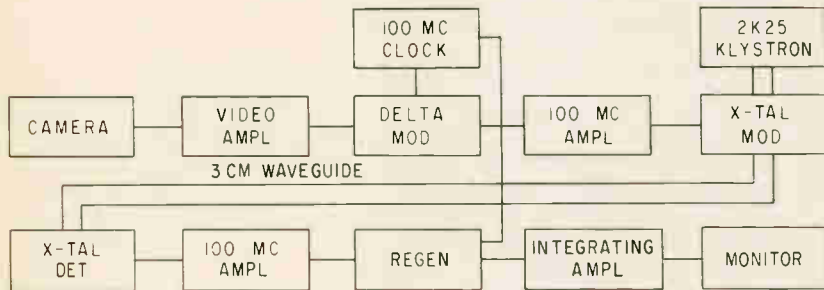
current. In this way the reconstructed signal follows the original signal closely with a difference of one step or less. As the delta-modulator differentiates the input signal, the video signal has to be integrated first, or fed in series with the inductance and resistance of the integrating network.

SINE WAVES — Shifted sine waves can be used instead of rectangular supply pulses. The output signal of the delta-modulator then consists of positive and negative half-sine wave pulses about 5 nsec wide.

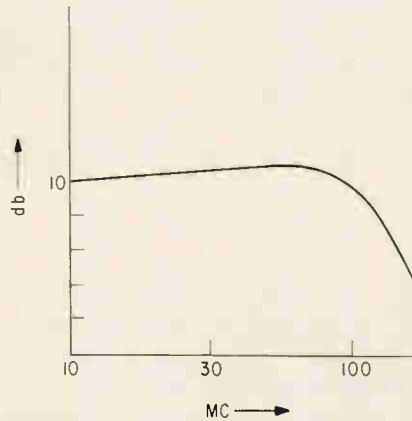
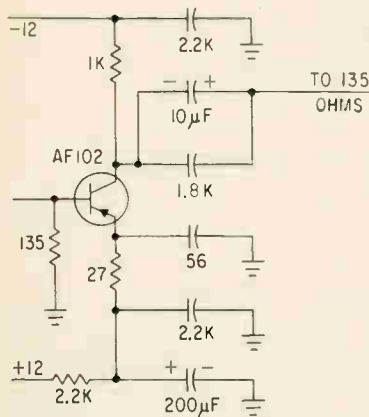
It must now be determined whether these pulses can be transmitted through a H_{01} -mode waveguide circuit where the distance between repeaters is 25 Km. A principal cause of distortion in waveguide circuits is dispersion,



UNDER the transparent lid at left is the delta-modulator consisting of tunnel diodes and coil. Modulator circuits are contained in the four boxes



SIMULATED long-distance waveguide transmission link shown also in the photograph—Fig. 3



LARGE bandwidth (right) is obtained in 100-Mc amplifier stage using emitter feedback peaking—Fig. 4

which causes different sidebands of the same signal to arrive at different times. This dispersion can be calculated by

$$\lambda_g = \lambda_0 / \sqrt{1 - \lambda_0^2 / \lambda_c^2}$$

where λ_0 = free space wavelength
 λ_g = guide wavelength
 λ_c = cut-off wavelength of the guide
 l = length of waveguide

By $\tau = l/v - l/\lambda_g$, this can be written as $\tau = \tau_0 \sqrt{1 - f_c^2/f^2}$ where τ_0 = transmission delay in free space

f = carrier frequency
 f_c = guide cut-off frequency

By differentiation

$$\frac{\Delta\tau}{\tau_0} = \frac{f_c^2/f^2}{\sqrt{1 - f_c^2/f^2}} \frac{\Delta f}{f}$$

Considering a circular waveguide with $d = 5$ cm ($f_c = 7,320$ Mc for the H_{01} mode), $\lambda_c = 4$ mm and $l = 25$ Km, then $\Delta\tau = 4.16$ nsec for a signal with a bandwidth $\Delta f = 200$ Mc. This means that 5 nsec pulses are widened by the dispersion to about 9 nsec. Since the distance between two succes-

sive pulses is 10 nsec, this distortion does not make the pulses unrecognizable.

Because it is not practicable to use 25 Km of circular waveguide for the experiment, the circuit was simulated by using rectangular 3 cm waveguide. Here the dispersion per unit length is much larger because f_c/f is large. With $f_c = 6.560$ Mc, $f = 9,200$ Mc and again $\Delta f = 200$ Mc the value of $\Delta\tau/\tau_0 = 0.0155$. If $\Delta\tau$ should again be 4.16 nsec, τ_0 has to be 269 nsec, so $l = 80.5$ m. This is a reasonable length of waveguide to use in the laboratory. As shown in the oscillograms, $\Delta\tau$ is indeed about 4 nsec.

SYSTEM—The transmission circuit is shown in Fig. 3. The signal output of the camera is amplified and supplied to the delta-modulator. The pulse output of the delta modulator is amplified by a four-stage 100-Mc bandwidth amplifier, one stage of which is shown in Fig. 4. After amplification, the pulses amplitude-modulate a 3 cm carrier by means of a wideband crystal modulator.

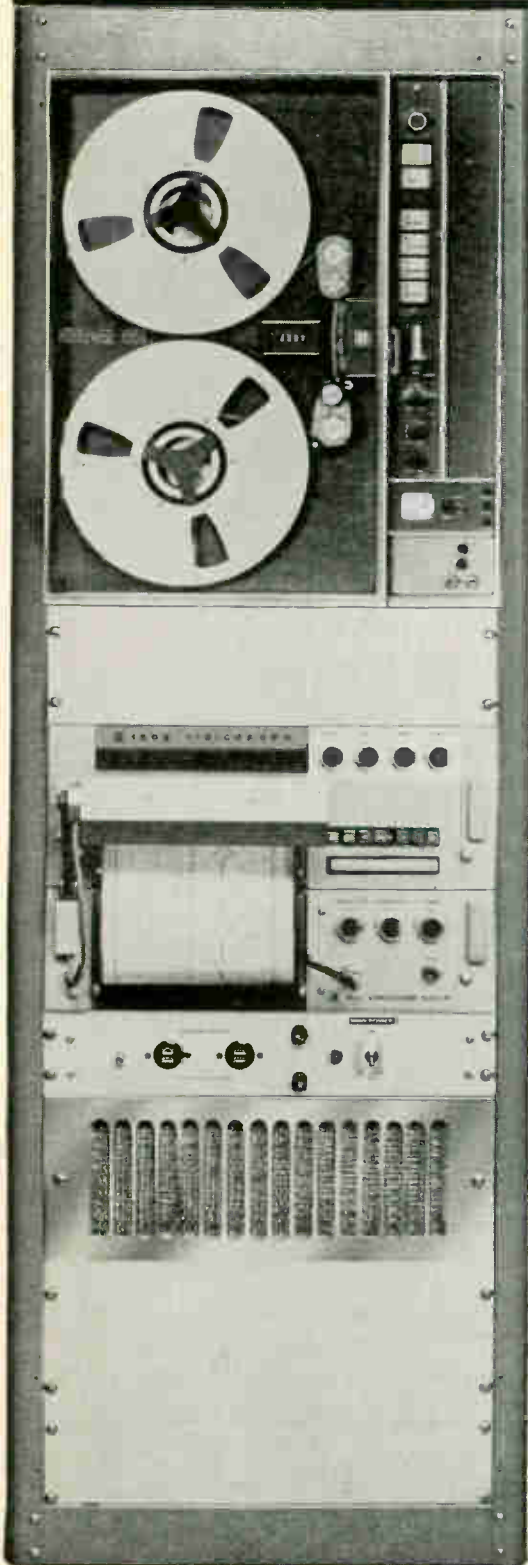
At the receiving end the pulses are detected by a 3 cm crystal detector and again amplified in a four-stage 100 Mc amplifier. The amplifier pulses control a tunnel diode pair, which is fed by a 100 Mc shifted sine wave in such phase that the start of a 100 Mc supply pulse coincides with the peak of a signal pulse. The signal pulses are thereby restored to their original shape and the distortion and noise are removed. The regenerated pulses are then integrated to obtain the original tv signal. The picture on the monitor shows that the signal suffers little degradation during this series of modulating and demodulating processes.

The authors thank R. Muller and E. de Boer for assistance in constructing and aligning the equipment.

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- (3) J. C. Balder and C. Kramer, Video Transmission by Delta Modulation using Tunnel Diodes, *PIRE*, 50, 4, p 423-431, Apr. 1962.

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Infrared Mine Detector a Reality

Basic experiment shows infrared mine detection technique feasibility

By W. E. OSBORNE

Whittier, California

INFRARED detection techniques developed in the past ten years have made it possible for an infrared receiver to detect differences, at close range, of less than 0.001 deg F. Such sensitivity has suggested interesting new applications.

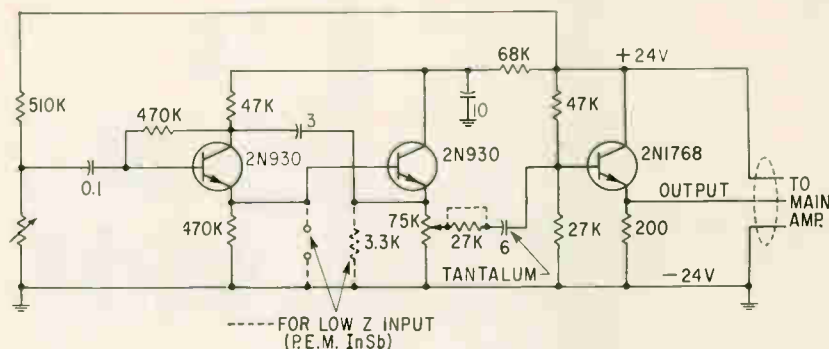
One such application is the detection of explosive mines buried in soil. To investigate the possibilities for such detection, experiments were run with a simulated mine at different depths, and showed that this is a promising field for further research.

All materials and objects emit and absorb radiation as a function of their temperature. While the emitted radiation results from the acceleration of electrical charges within the material, and is therefore electromagnetic in nature, radiative behavior is usually explained in terms of thermodynamics. In the case of mine detection by infrared, the system depends on determining any significant temperature differences in the ir radiation of different small sections of a given area. Parameters such as emissivity and spectral radiant power are secondary in this instance, as the main concern is detection of radiant intensity differences in terms of watts/steradian, along a strip of ground about 10 ft. wide.

Theoretically, a mine, or any other buried object, should reach an equilibrium temperature equal to that of the surrounding soil, after a certain period of time, provided the material in each case is the same. Kirchoff's law for such conditions shows that the absorp-



SIMULATED MINE was plastic bucket containing metal objects, fabric and fertilizer. Infrared detector, amplifier and readout meter shown at right—Fig. 1



DETECTOR HEAD preamplifier carries signal from lead telluride detector cell over a 200-ohm output to main amplifier—Fig. 2

tance of the mine then equals its emissivity, or reradiation efficiency factor. However, a marked difference exists between the material composition of the mine and its surroundings. The radiant emissivity, absorptance and reflectance are therefore considerably different, irrespective of whether the weapon is plastic or metal, and it is detectable as either a warmer or a colder object than the surrounding soil.

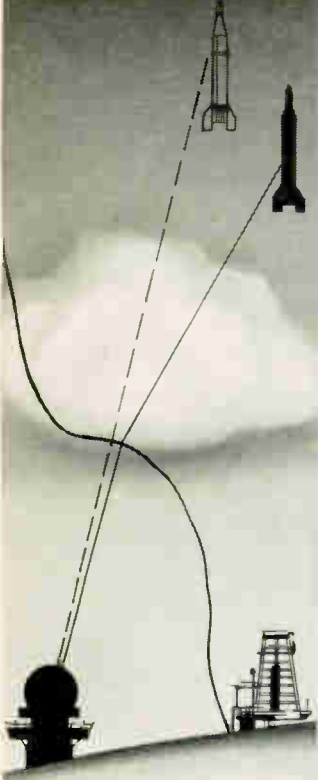
A parallel is provided by a packet of frozen food in an almost empty freezer. It may be immediately located by an infrared detector

inside the freezer even though the food has been frozen for weeks.

PROCEDURE—Experiments were conducted with a receiver using a lead telluride cell, responding at 6 microns, and cooled with dry ice. Although the amount of incident radiant energy receivable by this cell was only about four percent of maximum (at 55 deg F, a receiver peaking at 10 microns would be preferable), a very usable signal was obtained with the target buried at 18 inches (see Fig. 1).

One week later more checks were

REFRACTOMETER



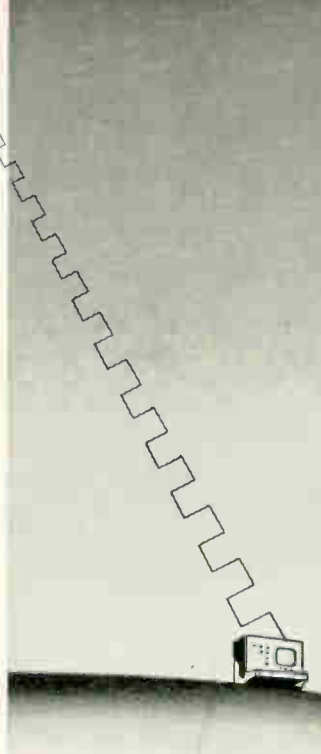
Colorado Research Microwave Refractometers enable tracking systems to determine with new accuracy variances of radar wave velocity caused by variances in refractive properties of the atmosphere.

SHAFT ANGLE ENCODER



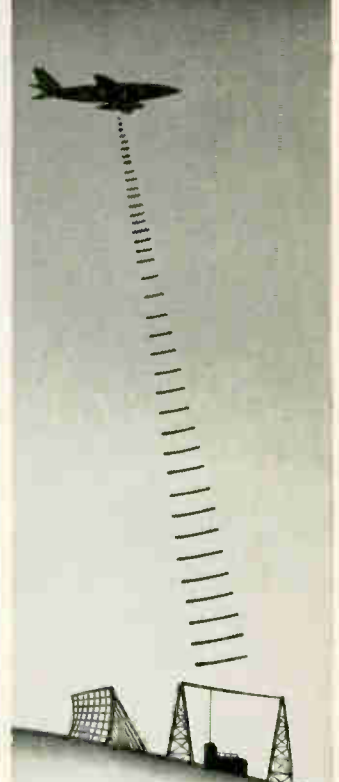
Measurement of shaft position with high precision has been made possible by the Colorado Research Microgon Shaft Angle Encoder System. Measurements with an accuracy of 1 part in 2^{21} make the system invaluable in the encoding of azimuth and elevation shaft angles of tracking systems.

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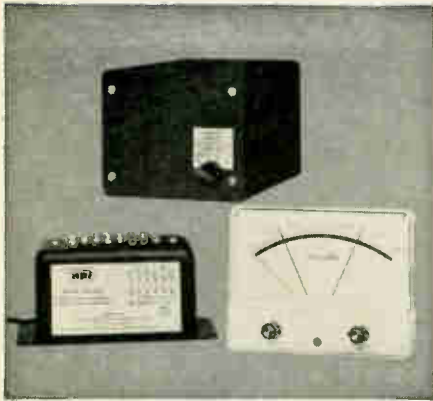
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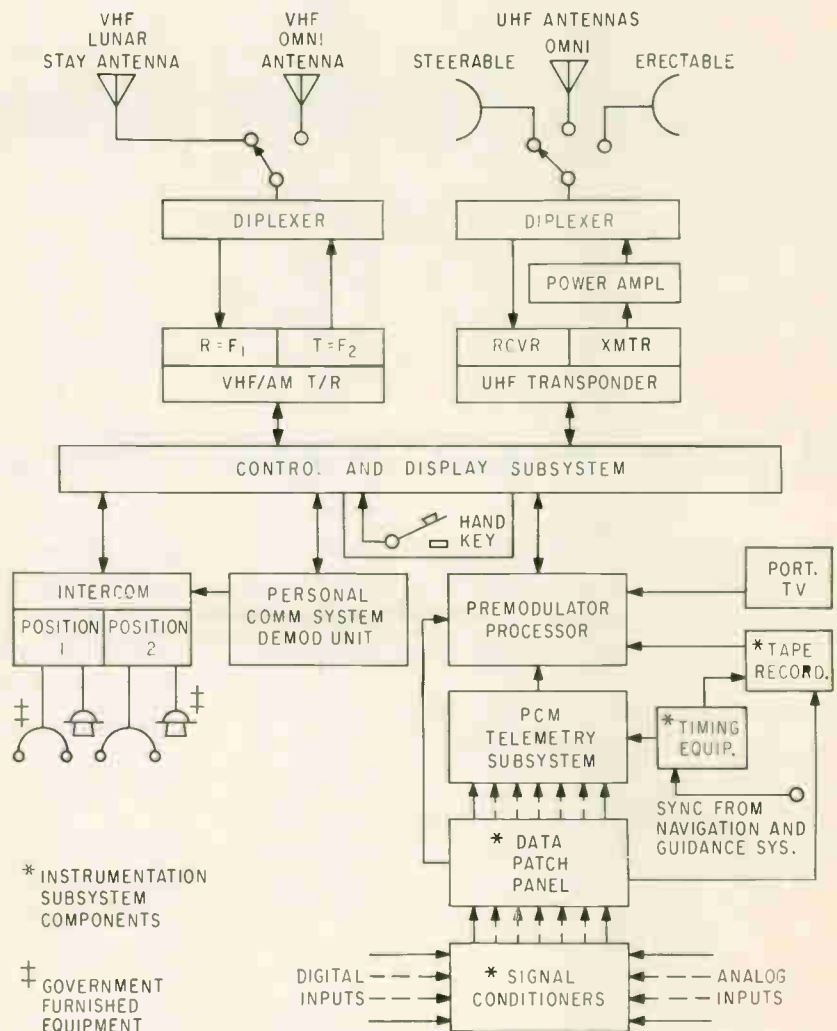
made, to evaluate the effects of time and weather. Even with no rain, the signal strength had fallen by about 18 percent, but the "mine" could still be easily found with a temperature difference signal of about 1.5 deg F, which was then attenuated by the covering soil.

The target was then retrieved and buried in another spot, where the readings almost duplicated the previous measurements. When the soil was thoroughly watered, the

signal dropped almost to noise level. About 3 inches of soil were removed, leaving 15 inches of damp soil as the detection threshold.

INFRARED RECEIVER—The test receiver contained an elementary reticle driven by an a-c motor. A preamplifier (Fig. 2) was mounted in the gun-like cell-chopper housing, kept at a measured distance of 2 feet from the ground during tests. Chopping frequency was 200

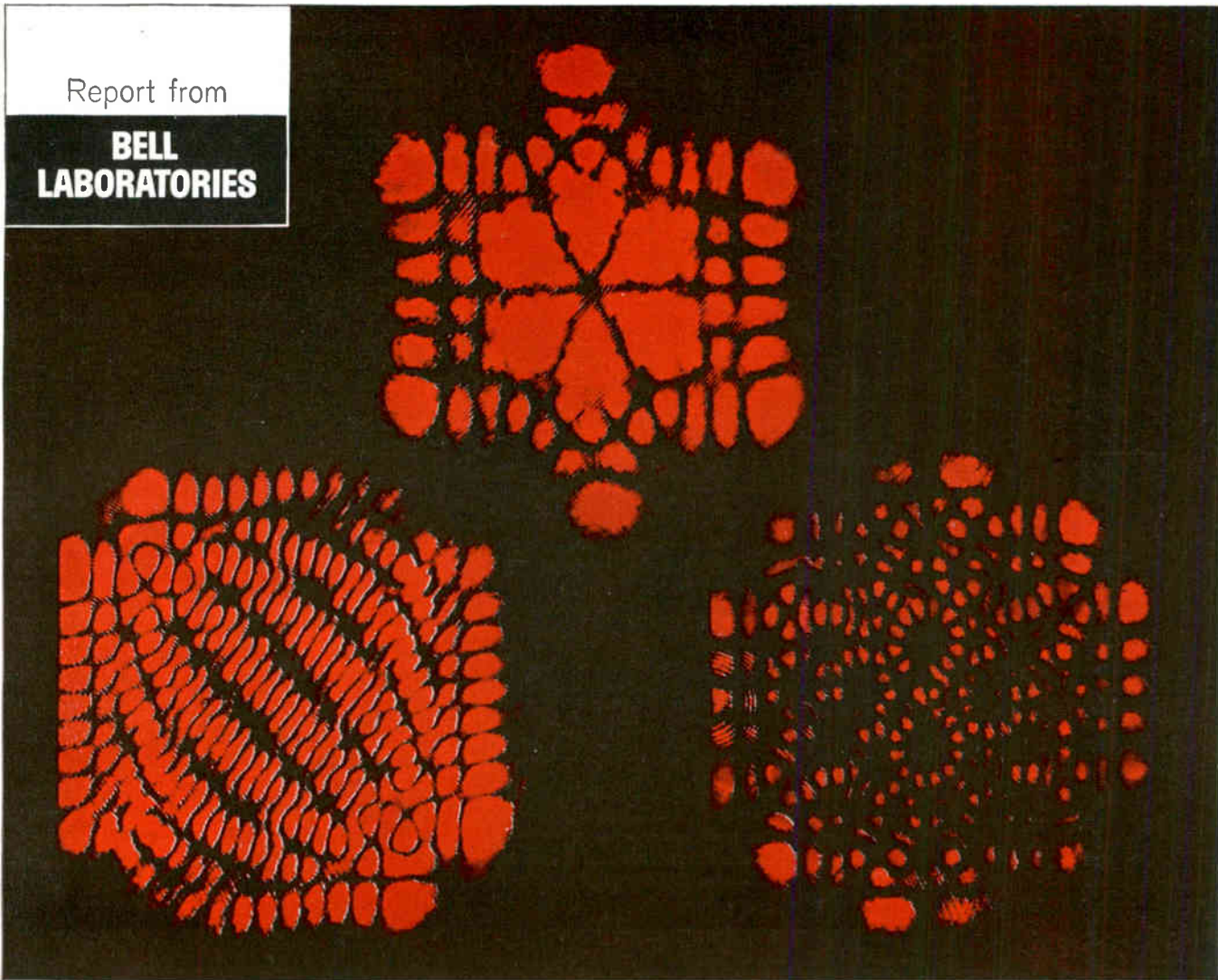
LEM'S Five-Way Communications



LUNAR EXCURSION MODULE for the Apollo manned moon flight (*ELECTRONICS*, p 22, July 19) will carry a communications system like this, say NASA sources. Equipment will be used for communication from (1) astronaut to astronaut in LEM, (2) astronaut to astronaut on the lunar surface, (3) astronaut in the command module orbiting the moon to LEM, (4) LEM on the lunar surface to the command module and (5) LEM to earth, both radio and tv links. One on-board camera will provide real-time video information for transmission to earth-based receiving station while LEM is moon-based

Report from

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To produce these mode patterns, the normal operation of a helium-neon optical maser is perturbed by placing a pair of wire cross hairs in the cavity. These wires interact with the mode structure of the unperturbed cavity, suppressing some modes and, in certain cases, coupling others together. By changing the angle between the cross hairs, this interaction can be altered and different mode patterns, as shown, can be produced.

A STEADILY GROWING FAMILY OF OPTICAL MASERS

Scientists at Bell Telephone Laboratories are continuing extensive research programs to gain increased knowledge about optical maser (laser) action. The immediate goal of these investigations is more complete understanding of the phenomenon itself. In the long run, however, this knowledge will help us to evaluate better the communications applications.

One aspect of optical maser research is the study of the mode structures in laser cavities. The modes excited in a particular experiment can be identified by mode patterns, shown above, produced by directing the emergent beam onto a photographic plate.

Optical maser research at Bell Laboratories has resulted in a broad new field of radiation science. For instance, discovery of gas lasers also provided the first continuously operating laser. The active medium in this device is a mixture of helium and neon; its

operation depends on the excitation of neon atoms by collision with excited helium atoms. Originally, this system emitted infrared light, but recently it has been made to produce visible red and yellow light.

More recently, in another significant advance, our scientists have discovered two other new mechanisms for creating maser action in gases. One depends on the dissociation of oxygen molecules in mixtures of oxygen and neon or argon. The other takes place in pure noble gases—helium, neon, argon, krypton and xenon—and depends on a direct transfer of energy from accelerated free electrons to the gas atoms.

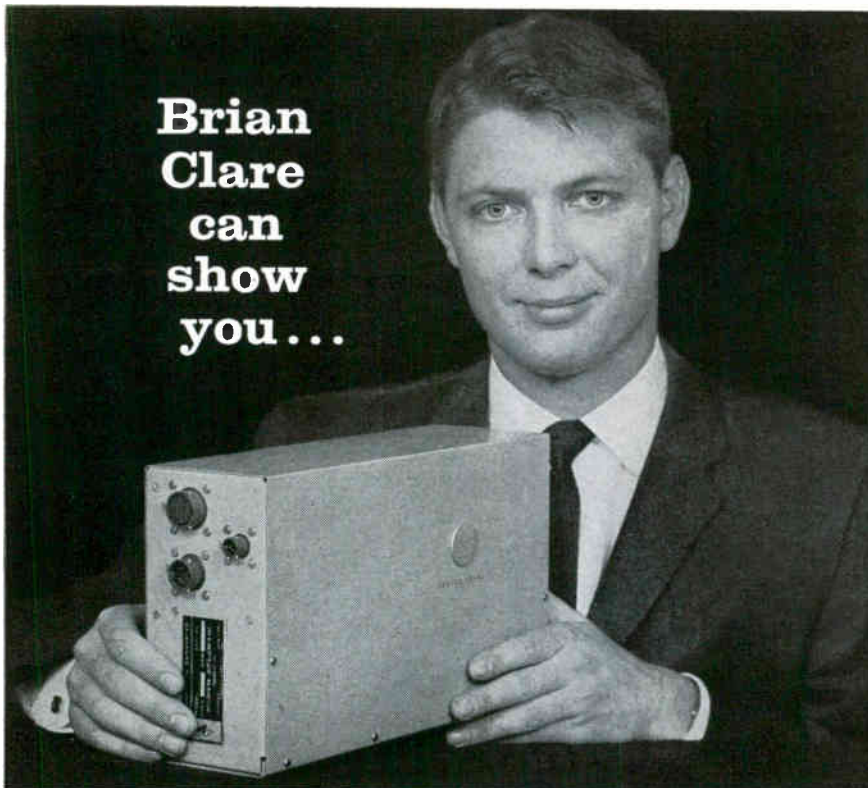
With these mechanisms and various gases or gas mixtures, we have achieved maser action at approximately 150 different wavelengths extending from 0.594 microns in the yellow region of the spectrum to 34.5 microns in the far infrared—and more are in prospect.



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Specifications of relay-programmed models PSC-410 and -411, and manually switched models PSC-415 and -416 are given in the table.

Voltage Range	PSC-410, PSC-415 PSC-411, PSC-416	1 volt to 300 volts f.s., 4 ranges 10 millivolts to 300 volts f.s., 6 ranges
Functions		Total, Fundamental, In-Phase Quadrature
Frequency Range		60 cps to 10kc 0.5 sec. 350 cps to 10kc 0.1 sec.
Phase Sensitive		Single frequency from 60 cps to 2kc.
Input Impedance		1 megohm
Output		-10 to +10 vdc into 10k load
Linearity		0.1% f.s. (10 mv dc)

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cps. The detector head contains a short collimator, a reticle wheel housing with motor container, and an insulated lead telluride cell container. Preamp output at 200 ohms from an emitter follower is carried to an R-C tuned main amplifier at 200 cps. The output was synchronously gated to reduce noise, and the display was a standard bench meter.

Hypoxia Warning Systems Developed by Beckman



OXYGEN SENSOR is an inch in length, less than 1/2 inch diameter, operates electrochemically independent of gravity pull and acceleration forces

PROTOTYPE hypoxia warning units, consisting of miniature oxygen sensors and lightweight amplifiers, have been developed by Beckman Instruments, Inc., Fullerton, Calif. for the Aerospace Medical Laboratory.

Hypoxia is the physiological impairment caused by lack of oxygen; it begins by mental slowdown similar to the effects of alcohol. The new warning systems will alert pilots when oxygen level falls below normal, by means of a warning light or audible alarm.

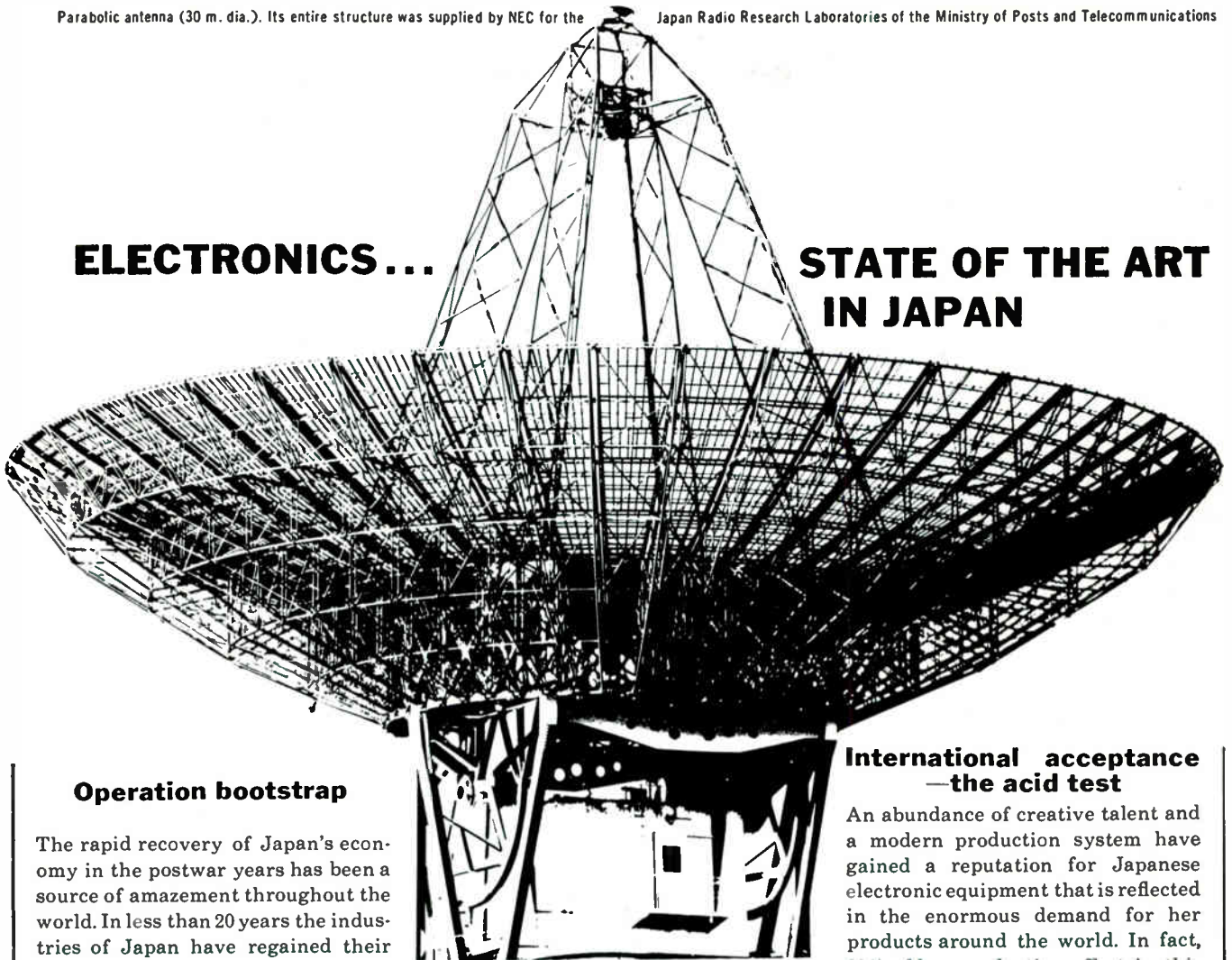
The \$159,250 contract calls for delivery of 33 such systems to the U.S. Air Force, for incorporation in the seat packs of F-106 and F-101B operational squadrons.

The hypoxia sensor uses a replaceable electrode cell to measure the partial pressure of oxygen, can withstand accelerations of 50 g's, as well as severe vibration.

A special amplifier for the warning system is drift-free, includes meter readout and an alarm circuit that can be preset to any partial pressure.

ELECTRONICS...

**STATE OF THE ART
IN JAPAN**



Operation bootstrap

The rapid recovery of Japan's economy in the postwar years has been a source of amazement throughout the world. In less than 20 years the industries of Japan have regained their positions among world leaders in their respective fields. In particular, is this true of the electronics industry.

In the past 6 years the annual value of Japanese electronic equipment has increased 7 times to almost \$2 billion—more than half of which is devoted to a multitude of consumer products: radio, TV, tape recorder, stereo, etc.

To serve her people Japan has constructed a microwave communication network for long-distance relay of telephone and television which extends to more than 2 million channel-miles—is second in size only to that of the U.S. She boasts 325 modern television stations and satellite stations, giving her the highest coverage density in the world. It has been NEC's privilege to supply over 96% of this microwave system and 60% of these TV stations. The result is that, today, the Japanese people enjoy the fruits of an electronic technology the equal of most great nations of the world.

Research & diversification —industry wonderdrug

But this is only one side of the coin. Japan's electronics industry has made great strides toward diversification, and at present research and production cover a wide range of industrial, technical and scientific activities.

Such recent developments as transistorized microwave equipment, a 2,700 channel super multiplex carrier telephone system, electronic telephone switchboard, and the gigantic parabolic antenna for space communication pictured above—all, incidentally, products of NEC—are typical of the variety of highly complex systems coming from Japan's laboratories. (The 98 ft. diameter antenna is Japan's contribution to the new worldwide TV relay network and, pending successful satellite launchings, will afford you a good chance of seeing Tokyo's 1964 Olympics.)

International acceptance —the acid test

An abundance of creative talent and a modern production system have gained a reputation for Japanese electronic equipment that is reflected in the enormous demand for her products around the world. In fact, 20% of her productive effort in this field now finds its way to overseas users. NEC's own export record—the largest in the field—reflects the international confidence placed in its equipment. For instance, the U.S. now imports NEC microwave technology; Spain takes broadcasting systems; the Philippines, a nationwide communication network; India and Pakistan, nationwide coaxial-cable carrier telephone networks; Australia, TV equipment; Thailand, new international shortwave telecommunication network. In fact NEC's overseas activities would more than fill this entire page.

The future—Japan, electronics and NEC

The future of Japan's electronics industry is no longer limited by technology—only by the heights to which the imagination of man can soar in finding new, useful and peaceful applications for it. It is NEC's intention to continue making a major contribution to these efforts.

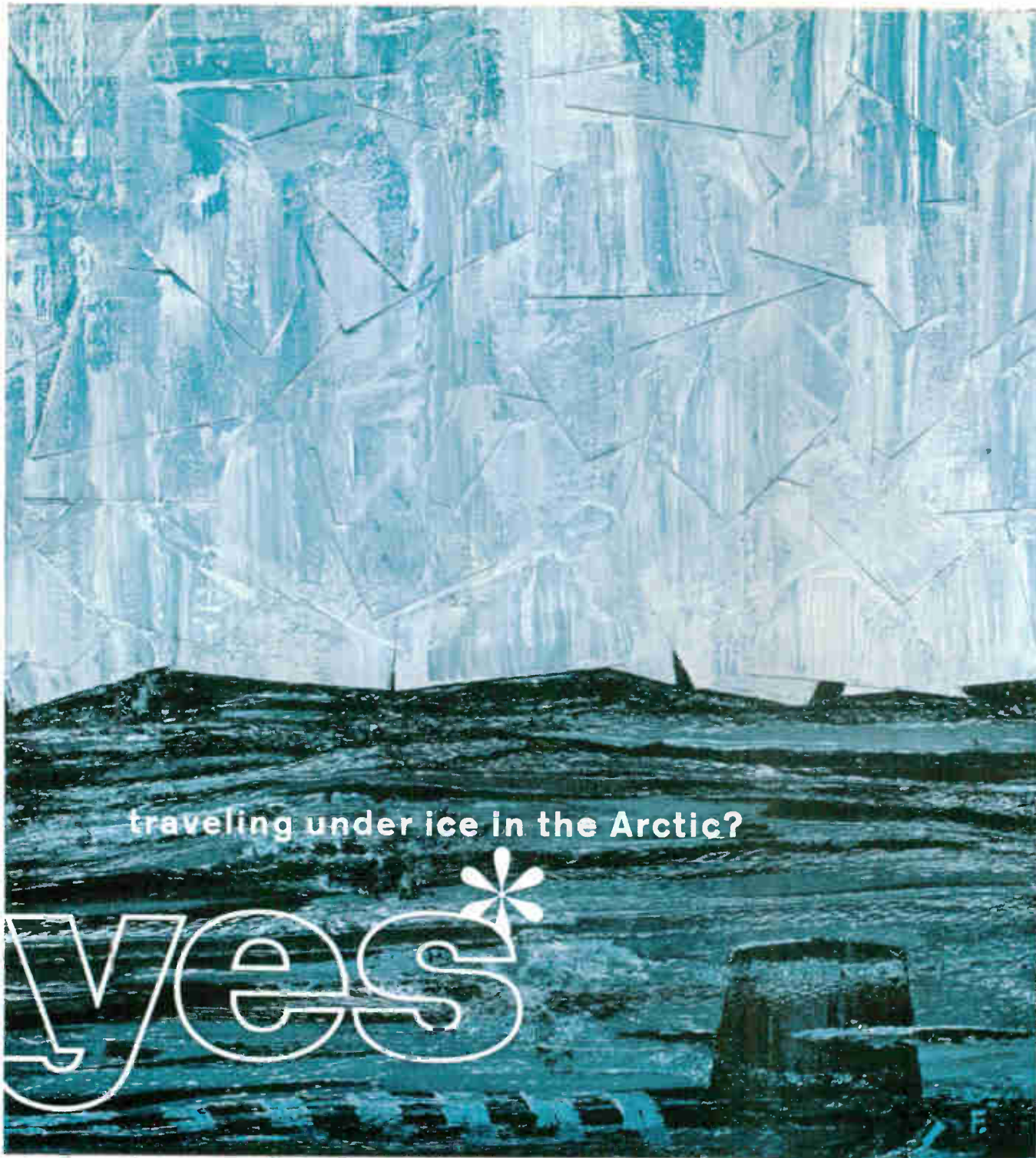
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UHF Transmitter Operates by Remote Control

New klystron meets FCC requirements for ultra-high-frequency television

A NEW KLYSTRON, now available for ultrahigh frequency broadcasting, seems to have anticipated the latest Federal Communications Commission's recommendation that will allow uhf transmitters to be operated by remote control.

In the spring, the FCC said that "while it is realized that presently available uhf transmitters require direct supervision by qualified technical personnel, the Commission feels that refinements can be made which will make remote control feasible".

Responding to the latest FCC stimulus, the Springfield Television Broadcasting Corporation of Springfield, Mass. applied for a construction permit for a uhf-tv station in Toledo, Ohio. They will operate a klystron transmitter by remote control. The broadcasting company intends to place the final amplifier on top of the antenna tower.

According to William L. Putnam, the company's president, the plan is to mount a klystron ampli-



AIR-COOLED power klystron is assembled by Amperex's John Nielsen. Transmitter will be installed in zig-zag antenna, at new uhf-tv site

fier with its accessories in a weatherproof steel drum, and ride the unit up the tower.

ON THE AIR—Positioning on top of the tower will be controlled by a pushbutton. A motor control will raise or lower the drum. When the klystron reaches a point at the top of the tower, the drum will automatically trip a switch and put the station on the air.

Power supplies and driver amplifier may be located on the ground, since piping and small signal r-f impose no difficulties.

The klystron has been made available by the Amperex Electronic Corporation of Hicksville, N. Y. The tube, designated type YK1001, is said to be the first fully air-cooled power klystron at the 10 Kw level which utilizes lightweight magnets for beam focusing. Magnet fields are readily adjustable by magnetic shunts.

At ultrahigh frequencies, the four-cavity klystron can produce 10 Kw of output power with only 10 to 50 watts drive. This depends upon the required band width.

For the same output, a typical tetrode would require 1 Kw or more of power drive.

Extension of the tetrodes first into vhf and then into uhf has been accompanied by a decrease in both efficiency and operating life, according to engineers. To overcome the effects of transit time and maintain the gain bandwidth product, high-frequency tetrodes must be made with extremely short electrode systems and close interelectrode spacings. The result is that the cathode surface area must be small and there is little room for reserve emission capability. In many cases, the grid, because of its inability to cope with high temperatures which result from the interception of part of the electron stream, becomes the bottleneck in tetrode design and can limit tube life. Moreover, as frequency increases, reactive currents go up, generating still more heat, Amperex says.

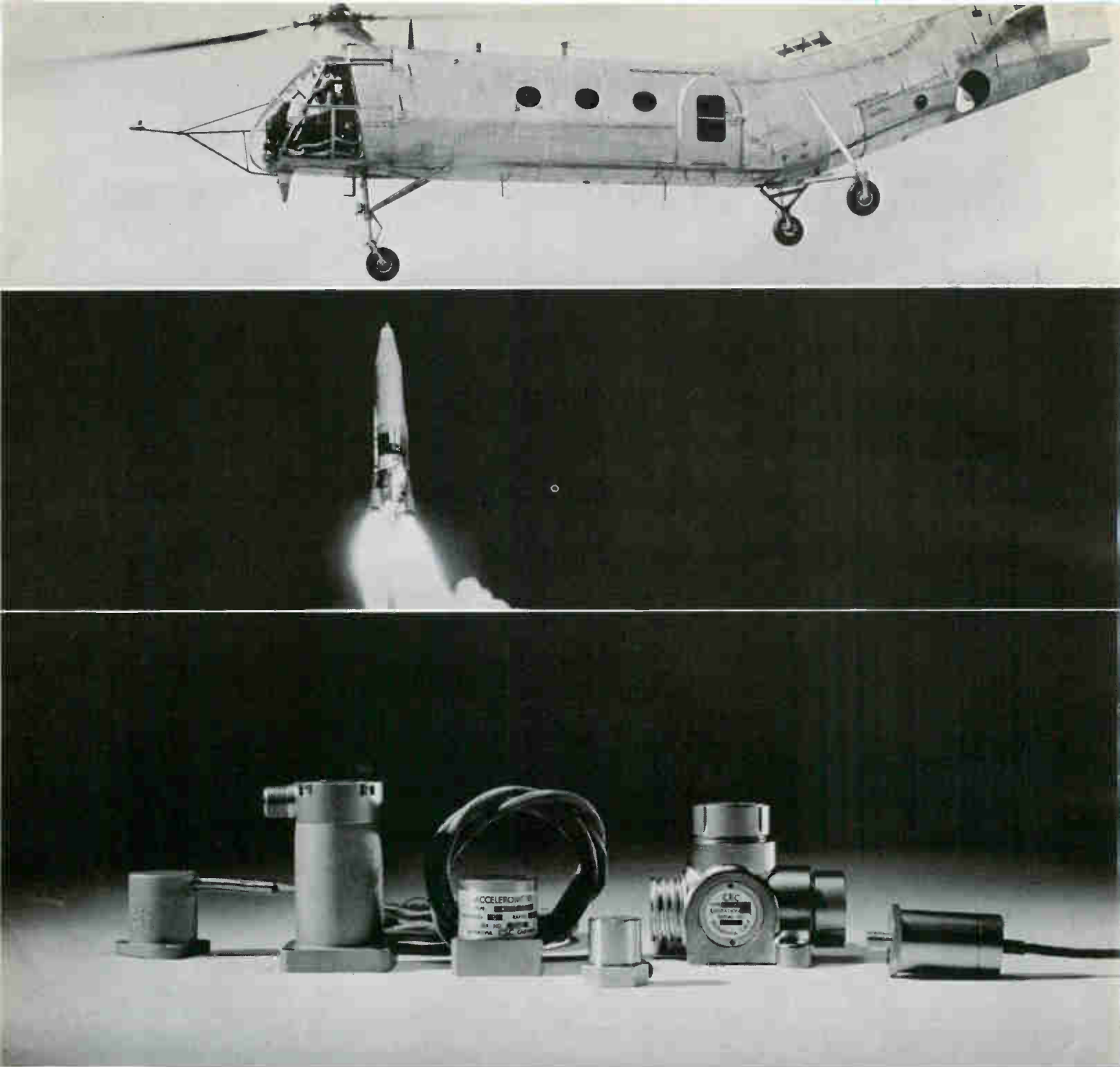
SYSTEMS GO FOR ALL-CHANNEL CHANGEOVER

The latest FCC recommendations on uhf-tv include changing the ratio of video to audio transmitter power from 2 to 1, to 10 to 1. In addition FCC grants permission to operate uhf-tv transmitters by remote control.

These moves can add up to substantial savings for broadcasting station equipment, and operating expenses. Economies may offer opportunities for new explorations into broadcasting.

The uhf-tv klystron, described in this article, was made available almost immediately after the latest FCC reports that will open up all-channel television throughout the country

NO ANTIFREEZE — Until recently, only water systems were used for cooling uhf high power klystrons. Cumbersome pumps were required, antifreeze was needed for outdoor environments, and corrosion problems plagued the equipment. Another disadvantage of previous klystrons was the need to provide a stabilized power supply for the operation of the beam focusing magnets. These



We second the motion

Any motion

Whether it's vibration, shock or acceleration, CEC's trio of motion measuring lines cover just about any move you can make. For sophisticated shock and dynamic acceleration problems (into high g and wide frequency ranges), CEC's piezoelectric accelerometers are outstanding. The unique 4-280 features output impedance less than 100 ohms, voltage sensitivity of 20 mv (peak)/g (peak) and electrical case isolation operating to 250 g (peak) from 6 to 6000 cps over temperatures that range from -65°F to $+200^{\circ}\text{F}$.

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In traditional vibration problems, you've got other reliable friends: CEC's vibration transducers. A newcomer to the family, the 4-126 is especially effective above 45 cps and between -65°F and $+700^{\circ}\text{F}$. Use it with any a-c voltage measuring device presenting a 10,000 ohm resistive load impedance.

Measuring both static and dynamic acceleration from d-c to medium frequencies? Try CEC's unbonded strain gage accelerometers. The 4-204 is tri-axis, bi-directional, measures from ± 5 g to ± 500 g, operating

temperature range is 70°F to 300°F .

For displacement or velocity readout, team them up with CEC's compatible 1-117 Vibration Meter. And, for an analytical system, the 1-117 may be coupled with CEC's 1-159 Variable Filter. Further data? Call or write your CEC office for Bulletins in Kit 3470-X1.

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CEC's 1-117 meters vibration velocity and peak-to-peak displacement at selected frequency. Features: 4 input channels; 4-stage single channel amplifier stabilized for extreme reliability. More information? Call or write for Bulletins CEC 1117-X2 and 1159-X5.

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CIRCLE 63 ON READER SERVICE CARD
electronics • August 2, 1963

magnets confine the electron beam and control the beam in the drift spaces between the cavities.

The new klystron solves both air cooling and beam focusing. Permanent-magnet beam focusing will be important in a tower installation. A dispenser cathode makes possible a tube with a life warranty of 5,000 hours.

The cathode is basically a porous tungsten sponge. This is processed with a monoatomic layer of barium which is resistant to emission poisoning, to high-voltage electrostatic fields, and to high-speed gas ions.

ION PUMP—A continuously-operating ion pump is employed with the YK1001 to maintain an extremely low level of gas, and provide continuous monitoring of the vacuum. This ion system is a vacuum-like device that uses electrical and chemical means to maintain vacuums in excess of 10^{-9} mm.

The ion getter pump is an integral part of the klystron circuit. It works when the tube operates, allowing continuous monitoring and check of the vacuum in the tube. Previously, klystrons have used flash getters of indeterminate efficiency, there being no means of directly checking the vacuum.

The new klystron is capable of efficient depressed collector operation. Flexibility of the tube is enhanced by a system of interchangeable cavities. One set is available for the high band (770-960 Mc), and another for the low band (470-790 Mc).

The high power gain of the tube enables the designer to simplify the earlier circuit stages for a more reliable transmitter. Typically, the YK1001 requires a driving power of 10 watts for an output power of 11 kilowatts. The power gain is 30 db.

Creating a Modern Drugstore for Materials

SIGNIFICANCE of a \$400,000 award to Materials Research Corporation by Advanced Research Project Agency is not in its size, but in the

fact that it is one of ten programs comprising a \$5 million dollar effort initiated by ARPA.

General framework of ARPA program centers around crystal growth techniques, the acquisition of precisely-defined crystals, and the characterization and analysis of crystals. MRC will contribute to area of high-temperature metal and ceramic materials.

Sheldon Weinig, MRC president, says impact of whole program will be great in area of solid state development. "We have been inspired by the idea of creating a modern drugstore for materials", says Weinig. "The researcher sends in his prescription and we produce the crystal to his order. With this ARPA grant, we will be able to expand our services and increase the efficiency of research."

The first of MRC's materials breakthroughs, and one that encouraged the company to establish their Advanced Materials Laboratory, was the production of extremely high purity refractory metal crystals on company's own electron beam zone refiner. The first products were single crystals of tantalum, molybdenum, tungsten and columbium with aggregate interstitial impurities of less than 25 parts per million. The crystals were offered to researchers with the request that they specify purity levels and orientation. Thus the materials drugstore was born.

Navy Report Defines Microcircuit Functions

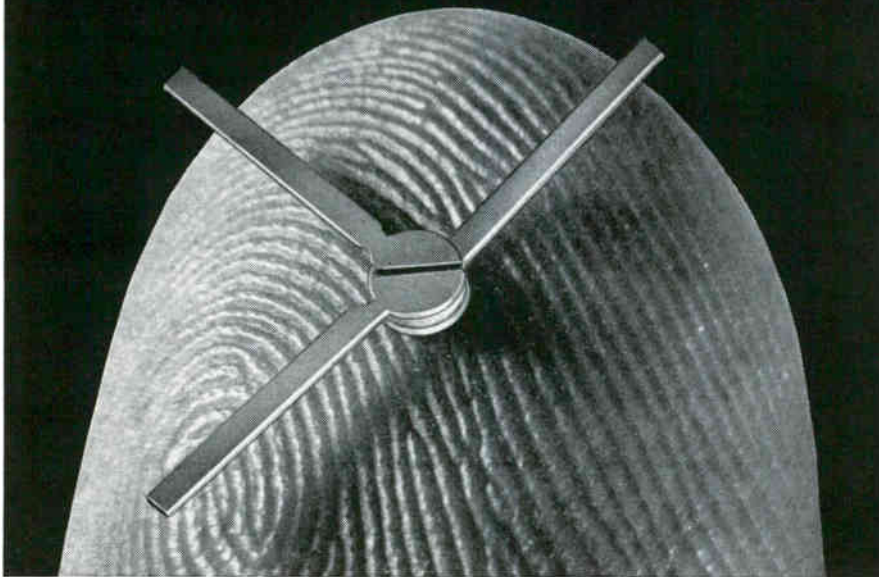
A REPORT on the work that Battelle has done for the Navy, defining circuit functions for microminiature equipment, has been issued by ASTIA (now the Defense Documentation Center for Scientific and Technical Information).¹

These functions are not being proposed as standards at this time. However suggestions are given with a view of presenting over-all functional characteristics of silicon block circuits.

The circuits need not be specified in terms of individually recognizable component parts. Aim is to specify a device by describing the



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output, input and transfer characteristics and its variations. Prototype circuits are included for reference purposes, and are not considered restrictive as to design approach. Guides are given to basic function performance ranges.

Navy spokesmen say that no substantially new functions have been created recently.

The report on Information on Microelectronics for Navy Avionics Equipment was issued by the U.S. Naval Air Development Center in Johnsville, Pennsylvania. Evaluation of Navy microcircuits is now being transferred to the Naval Ammunition Depot, Crane, Indiana. The Crane facility will evaluate commercially-available modules and functional blocks and will issue reports on findings.

Work at Johnsville will now be confined to the application of microelectronics to Navy equipment.

The Johnsville facility is now working on a one-way data link for an automatic carrier landing system. An all solid-state digital system, designed at Johnsville, will record the plane's position. This information will be transferred from carrier to aircraft.

The receiver in the data link system will be miniaturized, but will not use silicon block circuits.

REFERENCE

(1) Information on Microelectronics for Navy Avionics Equipment, Report NADC-EL-6319, Micronotes No. 3, 5 June, 1963 (Micronote No. 1 was issued 26 July, 1962; Micronote No. 2 was issued 26 Nov., 1962), Defense Documentation Center, Alexandria, Va.

Reed Relay Encased In Phenolic Tube

A LOW-COST, long-life dry reed relay has its coil assembly encapsulated in molded plastic. Unit was designed by Grigsby Company, Inc., Arlington, Illinois, for direct mounting on printed circuit board.

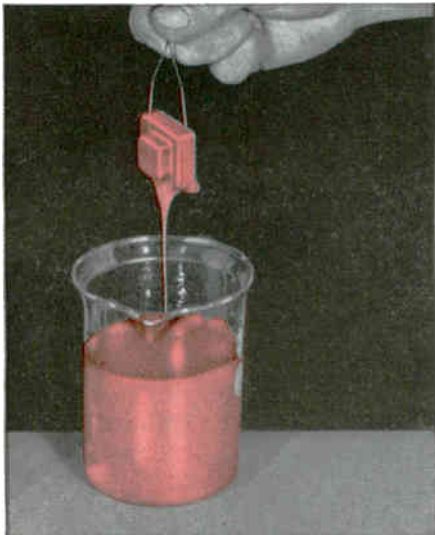
Design permits automatic assembly and easy reed replacement.

The reed is cradled in the bore of the bobbin, and therefore easily replaceable. Operating temperature range covers -55 C to 130 C. The coil subassemblies in standard voltage ranges are carried in stock and a wide range of reed switches con-

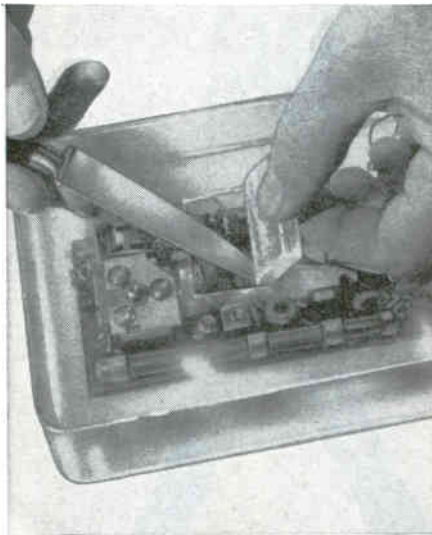


What you can do with General Electric's RTV silicone compounds

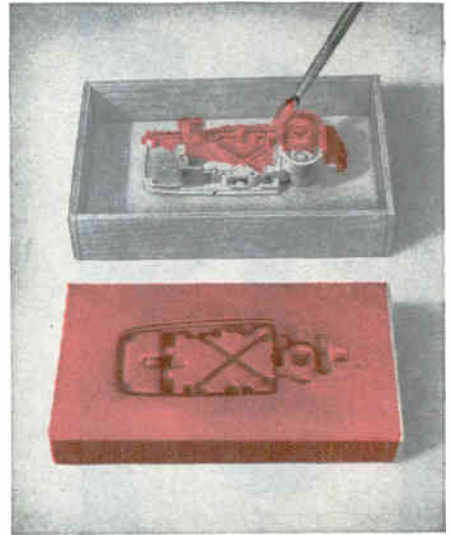
to insulate, seal and mold from -150°F to 500°F



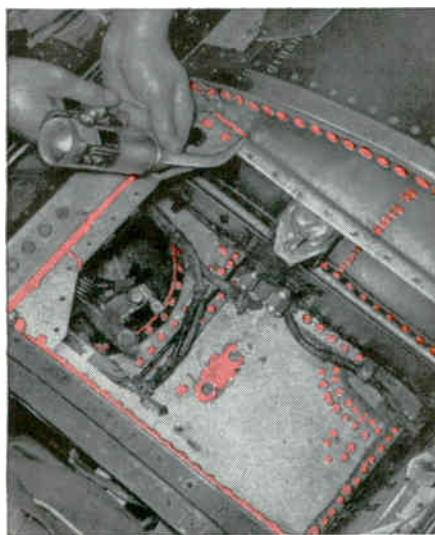
Encapsulate it. Fluid RTV silicone rubber penetrates deep into transformer coils. RTV has excellent dielectric strength and practically no shrinkage. Cure time at room temperature can be varied from minutes to hours.



Pot it. Transparent or opaque, G-E silicones provide a resilient protection against moisture, ozone, thermal and mechanical shock. Flows freely around complicated parts, can be cut away to replace internal components.



Duplicate it. Flexible RTV is often used to make molds for prototypes and short run production. This part requires deep undercutting, but duplicate parts flex free easily. RTV's tensile strength is as high as 850 psi.



Seal it. Bondable RTV (when surface is properly primed) seals against moisture and vibration, ozone and chemicals. Can be used for sheet metal fabrication, shock mounts, gasketing. Viscosities range from pourable to paste.



Insulate it. Adhesive/sealant RTV-102 requires no mixing of catalyst, can be used to insulate open wiring, for on-the-spot caulking, gluing and soldering. RTVs are virtually ageless, will not stress-crack or weather.



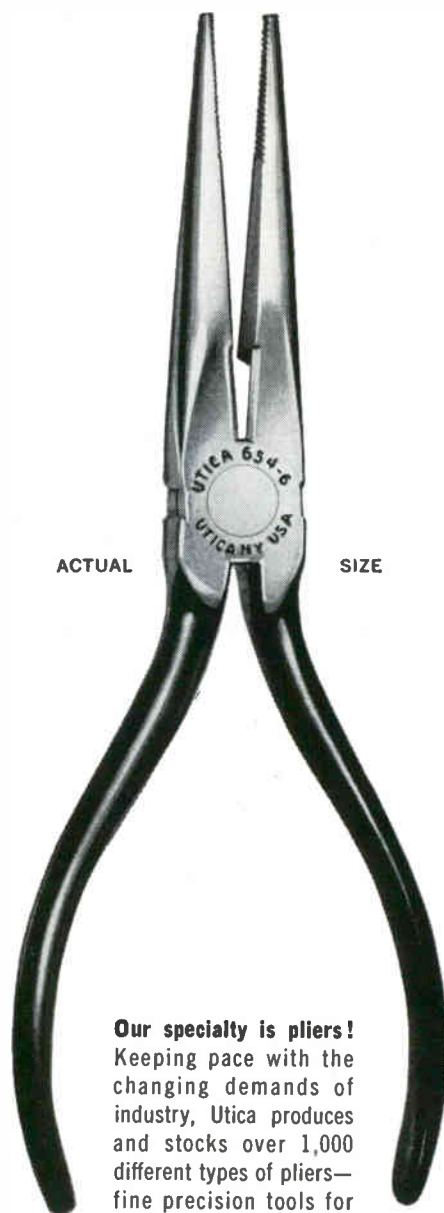
Manufacture it. RTV adhesive/sealants are fast working assembly tools, eliminate prefabricated parts or more costly, time consuming techniques. Here an RTV adhesive laminates flexible mica strips to form cylindrical ducts.

If you would like a free sample of one of the nine General Electric RTV silicones for evaluation, write on your letterhead, describing your application. For additional information, check reader service card. Section N895, Silicone Products Dept., General Electric Company, Waterford, New York.

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tact systems are available for multicircuit applications. Unit measures 1 $\frac{3}{8}$ -in. long by 0.425-in. dia. Voltages are 6-v d-c, 12-v d-c and 24-v d-c at 250 milliwatts. Special coil impedances are available.

Applications for the encapsulated reed include use in instrumentation, transistorized drives and computers.

New TWT Developed For Satellites

A NEW TRAVELING wave tube amplifier will be developed for the Air Force by Eitel-McCullough. The new tube, power converter, telemetry and control circuits will be combined in a single package designed to have a useful life of 50,000 hours.

The project will take 30 months and will be carried out in Eimac's Microwave Tube Division Engineering Laboratories, San Carlos.

Advance Claimed for High-Resolution Display

A NEW and original method has been developed for preparing electrophoretic screens directly on glass surfaces. The new process is said to have important advantages over fine settled screens and over electrophoretic screens deposited on ECG coated glass.

The two latter types represent the present state-of-the-art for phosphor screens. CBS says that their new developments, made under an Air Force program are, therefore, advances in the state-of-the-art of high-resolution screens.

Microwave Tubes Will Use Tunnel Cathodes

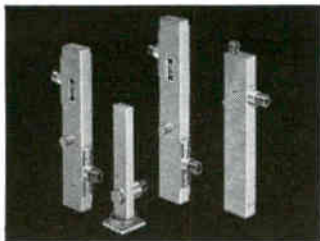
A THIN-FILM capacitor cathode will be developed for microwave tubes. Stanford Research Institute has been working on tunnel cathodes for the Air Force. Evaporated cadmium sulfide films and other dielectric layers have been investigated. Present work indicates that better techniques must be found for depositing thin uniform films of the dielectric.

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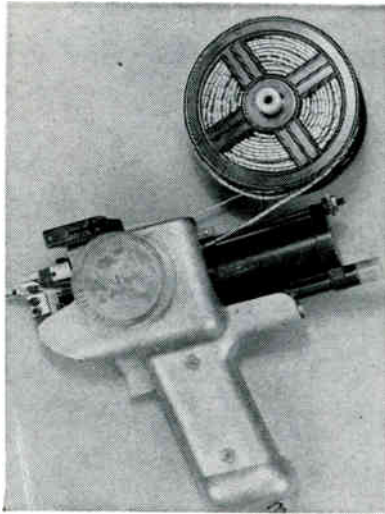
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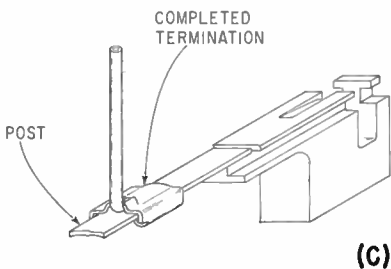
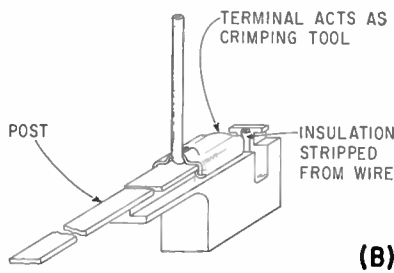
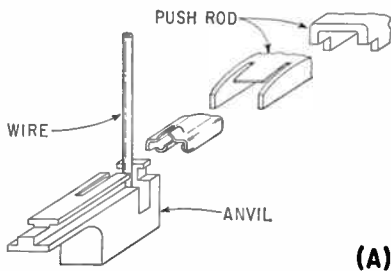
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CIRCLE 202 ON READER SERVICE CARD electronics • August 2, 1963

Tool Speeds Solderless Terminations



REEL feeds wire and strip connection terminals into small-nosed pneumatic tool that strips wire, affixes terminals into wire and slips terminals onto connection posts

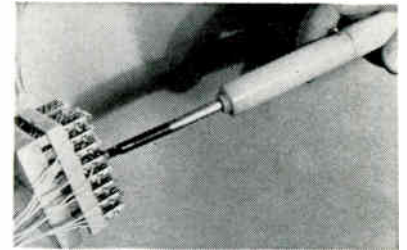


Automatically strips wire and makes post connections

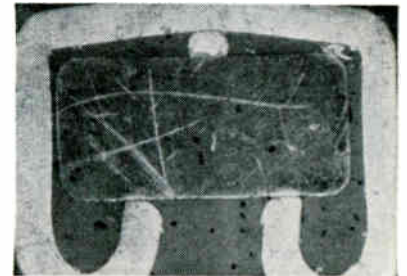
NEW DEVELOPMENT in solderless termination that permits high-speed connection of solid, stranded, printed, enamel and tinsel wires, has been announced by AMP, Inc. of Harrisburg, Pa. Strip-type terminals are used to make post-connections. Reportedly, the technique has a number of advantages over other solderless joining methods. These include increased density of connections and easier serviceability. Increased density is said to result from the combined use of the thin, metal terminals and a small-nosed pneumatic fastening tool. The company says the equipment is thus especially qualified for use on computers, switchboards, data processing equipment. Serviceability is enhanced with a hand extraction tool which can remove any one of a multiple number of connections in any position on the connection post without electrically disturbing the other terminations. Reconnection to post with pneumatic tool is made using a new strip-type terminal and the same wire.

OPERATION—Wire from a reel is loaded into an accessible funnel loading device on the pneumatic tool. The operator then trips the tool's trigger to initiate stripping of wire, affixing of connecting terminal into wire and slipping of terminal onto post with a wipe-clean action. Reel feeds both wire and terminals into tool which has an integral cutting device for cut-

OPERATION SEQUENCE: wire inserted into anvil of gun and push rod pushes terminal into wire (A and B); push rod then pushes terminal and wire into post (C)



NON-DESTRUCTIVE residual force test tool includes indicator in handle that registers tensile value of pull on connection



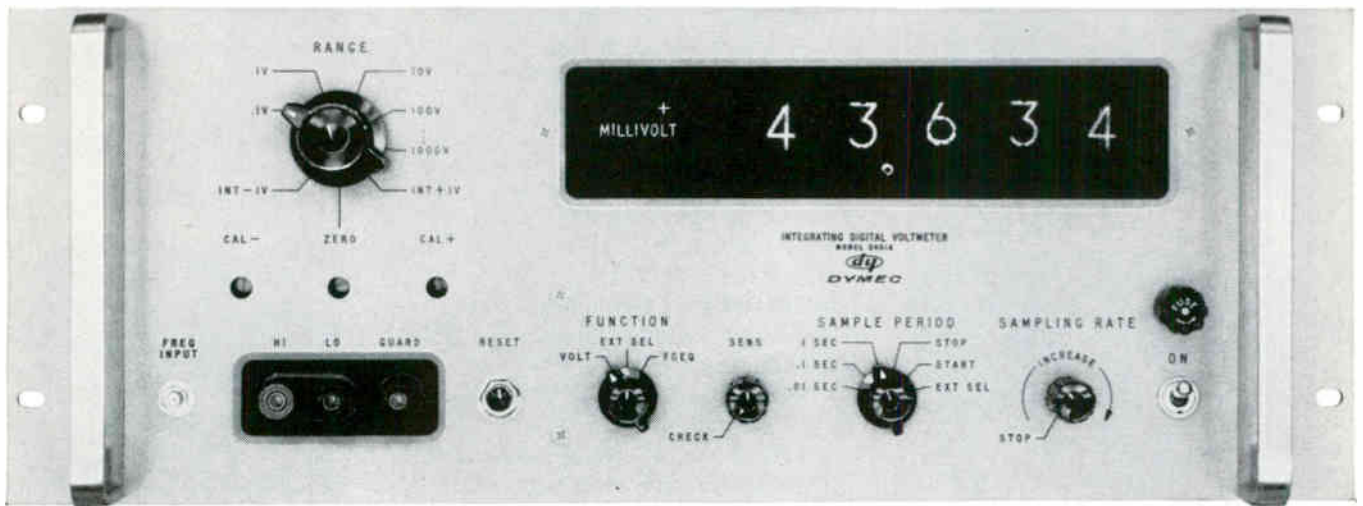
MICROSECTION shows wire being held onto post by spring action of terminal

ting wire to desired length. A wide range of wire sizes can be handled without changing tool or terminal, AMP reports.

HIGH PRODUCTION—Same connection technique is performed by a floor-mounted electro-mechanical machine for high-production operations. Guided by programmed instructions, the machine automatically makes connections point-to-point in horizontal, vertical and oblique directions.

RESIDUAL FORCE — Residual force in connections is claimed to be above normal-conductivity requirements and to be great enough to create a gas-tight connection between contact surfaces of wire and post. This is checked by a non-destructive terminal checking tool applied at the edge of the terminal. A slow-steady pull is exerted on the

MORE



measurements

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Standard features of the DY-2401A include full scale 5 digit ranges of 1 volt and 100 millivolts with 300% overranging! Flip a switch and your DY-2401A becomes a 300 kc frequency counter, with period measurements available as a standard option. Floated and guarded input circuitry permits extreme measurement flexibility. All functions and ranges are programmable of course. These are a few of the reasons why the industry's first integrating digital voltmeter is the most useful.

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ing operation permits measuring of the smallest signals . . . even in the presence of high common mode noise. Ten volts of common mode on the signal results in a mere one microvolt error, an unparalleled capability.

Accessory instruments include the DY-2411A Guarded Data Amplifier, which adds a 10 mv full scale range (again, with 300% overranging) while preserving the noise rejecting features. Input resistance is 10,000 megohms. The DY-2410A AC/Ohms Converter provides floated and guarded, broadband ac voltage and resistance measurements. Like the DY-2401A Integrating Digital Voltmeter, both accessory instruments are programmable by simple contact closures to ground.

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DY-2401A	\$3950
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DY-2411A	\$1150

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

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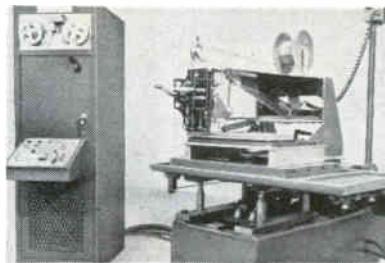
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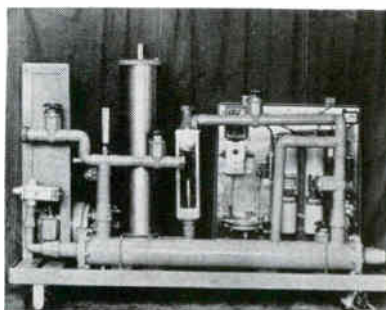
FLOOR-MOUNTED machine for high-production operations uses programmed instructions

tool handle until an indicator contained therein registers sufficient tensile strength.

ECONOMIES—Economies resulting from use of technique are attributed to:

- Speed and ease of application
- Use of bulk wire
- Absence of requirement for pre-stripped lead inventory
- Liberal post requirements: posts need not have sharp corners to form satisfactory contact.

Cooler for In-Line Testing



WATER-TO-WATER heat exchanger used to cool high-power radar assemblies is portable

ROLL-ABOUT COOLING system facilitates in-line testing of high-power electronic equipment. Cooling components mounted on three portable dollies now used by Raytheon's Wayland, Mass. plant, provide convenient flexibility.

Rolled to the equipment in test and connected by rubber hoses, the system is capable of dissipating a total 204,000 BTU's per hour. Included are a water-to-water heat exchanger, a Holstead and Mitchell closed circuit evaporative type water cooler, and a 5 h-p pumping

system. Able to be used with brackish or contaminated water supplies for the outer jackets, only distilled water in a closed circuit loop runs through the test fixture.

Designed by Harris Refrigeration Inc., Cambridge, Mass., this system eliminates the high cost of refrigeration units or the bulkiness of an air-cooled system.

Welding Press Floats on Air



OPEN-SPAN welding press uses electrical and pneumatic circuits for positioning weld material

MEDIUM-SIZED, high frequency open-span welding press is being introduced that has a sliding tray system using a flotation-on-air principle. Built by Stanelco Industrial Services, Ltd. of London, England, the welding press thus reduces operator effort. Also, air-flotation feature simplifies and economizes jig construction and permits upward facing electrodes. Air consumption has been cut to a minimum by adjustable stroke-limiting facilities for production use: a full 6 inches for setting up but ½ inch for running. Material to be heated is accurately positioned in the h-field immediately under the welding electrode through use of dual weld/dwell electrical and pneumatic circuits. Welding-time cycle and applied pressure can be adjusted independently of dwell time and pressure. Thus, pressure can be low during heat but can then become higher than normally permissible, increasing production rate.

MITSUBISHI MICROWAVE ANTENNAS FOR TELECOMMUNICATIONS



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

IU-61 6000 Mc. Band Parabolic Antenna

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



MITSUBISHI ELECTRIC CORPORATION

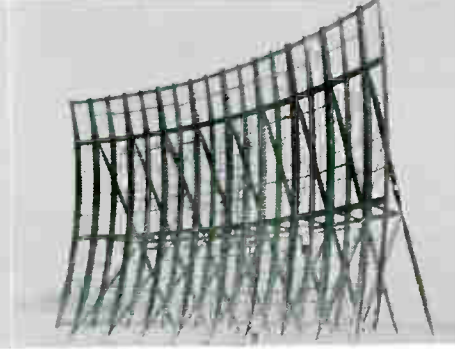
Head Office: Mitsubishi Denki Bldg., Marunouchi, Tokyo. Cable Address: MELCO TOKYO



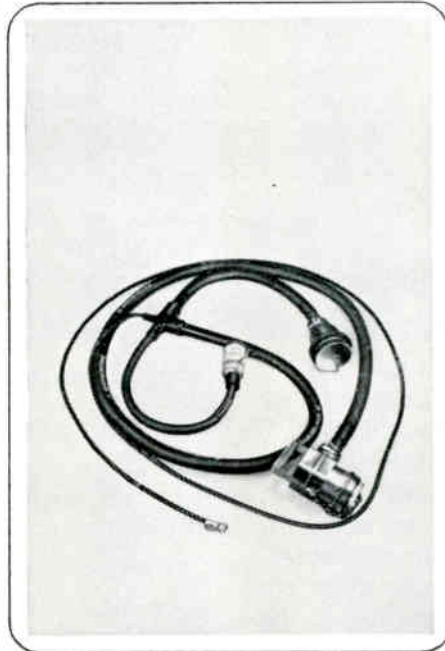
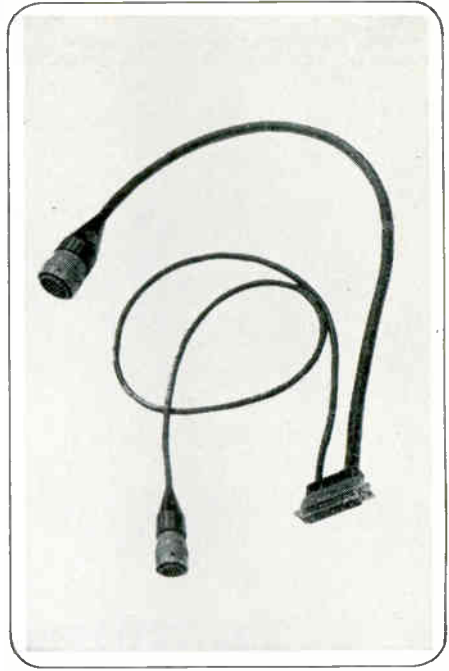
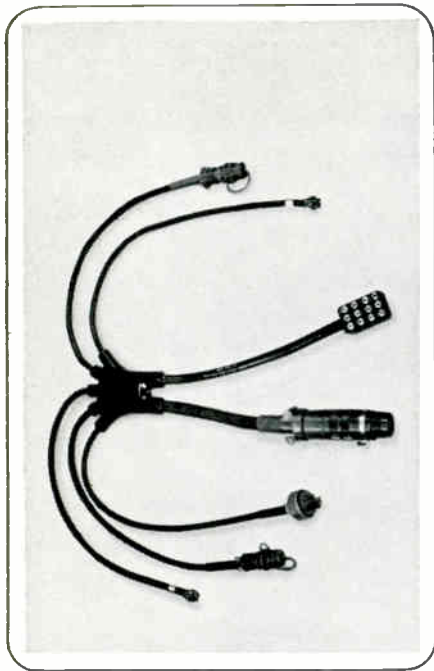
■ Horn reflector antenna



■ Air inflated parabolic antenna



■ 25×16 meter scatter antenna



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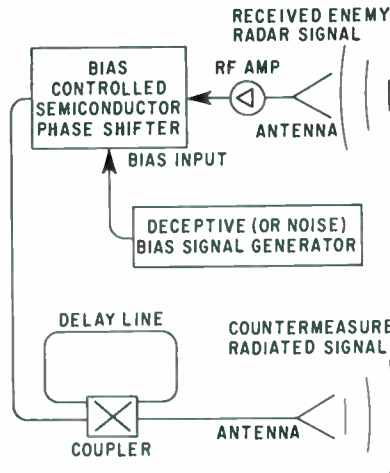
CITY _____ ZONE _____ STATE _____

L-Band Shifter Switches States in 10 nsec

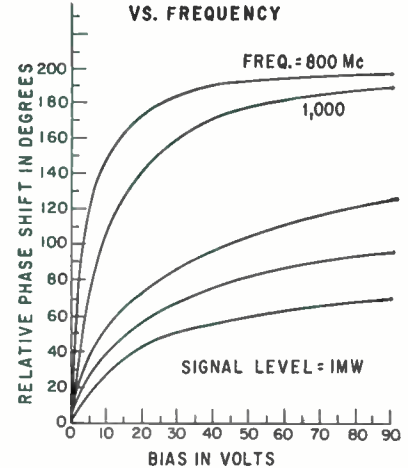
*Two-port device
uses varactors and
requires low drive*

RECENTLY announced by Microwave Associates, Inc., Burlington, Mass., model MA-8352-2LIT is an L-band, two-port transmission device that will provide continuous analog phase modulation by means of an applied bias voltage. Control is accomplished with varactors that require very low drive of less than 0.01 watt. The unit is capable of fast modulation rates including sinusoidal modulation signals to 30 Mc or switching between two particular phase states in 10 nsec.

According to the manufacturer, model MA-8352-2LIT has an r-f power rating (cw) of 100 mw, but may be used at higher levels if phase shift sensitivity with r-f power level is not objectionable. This device finds use in countermeasure applications where a signal may be phase modulated with random or deceptive information



and re-transmitted to its original source. In this way, accurate target velocity determination by interpretation of returned signal frequency deviation or phase change can be inhibited. Other applications include use in automatic impedance measuring bridges, production of a known phase increment, control of driver stages in parallel chain and use in high-power amplifiers. One application of the device in radar countermeasures is shown in the diagram along with a graph of



phase shift plotted against bias.

The L-band phase shifter conforms to the following characteristics: freq. range—800 to 2,000 Mc; power level—100 mw continuous; insertion loss—2.0 db max; minimum phase shift—800 to 1,600 Mc between 0 and 90 degrees; input and output impedance—50 ohms; bias range—0 to 90 volts at less than 100 μ a and vswr less than 2 to 1. The unit weighs only 1 pound.

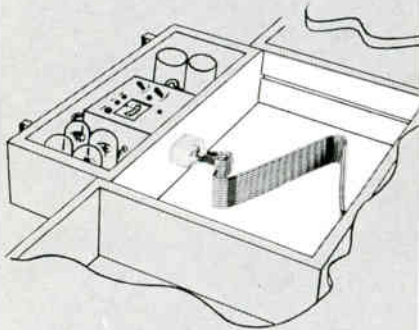
CIRCLE 301, READER SERVICE CARD

TWT Amplifier Has Modular Construction



MODEL 304D S-band twt Amplifier, soon to be introduced by Huggins Laboratories, Inc., 999 East Arques Avenue, Sunnyvale, Calif., operates between 2.0 and 4.0 Gc with 35 db of small signal gain, 1 watt saturation power output, 20 db maximum noise figure and spurious modulation at least 40 db below the signal. The unit has an a-m bandpass between d-c and 100 Kc and a minimum change in r-f output of 20 db with a grid voltage of 30 v. Connectors for r-f input and output as well as a grid-modulation jack are located on the front panel and servicing is facilitated by

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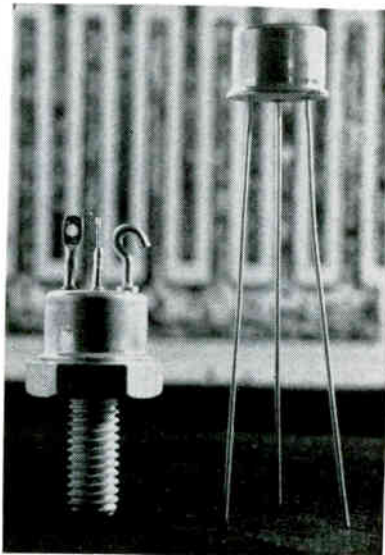
P.O. BOX 415, Tel.: 714 537-4530
TWX 714 530-0313
GARDEN GROVE, CALIF.

modular plug-in construction.

According to the company's engineers, adequate protection of the power supply and twt is ensured by fusing the main power line, high-voltage primary and filament circuit, and by incorporating a 3 minute filament warmup and helix-overload circuit. Excellent r-f stability is achieved with high-voltage regulation of 0.01%; a-c filament regulation of 2% and high-voltage ripple of better than 20 mv peak to peak.

Model 304D can be used to amplify the low output power of backward-wave oscillators and klystron signal generators, as an electronically controlled attenuator, for doppler radar simulation or shift generation and as an extremely stable oscillator to produce oscillations with stability on the order of 1 part in 10⁹. The device operates on 110 vac, consumes 1,000 watts maximum and weighs 37 lb. It costs \$2,250.

CIRCLE 302, READER SERVICE CARD



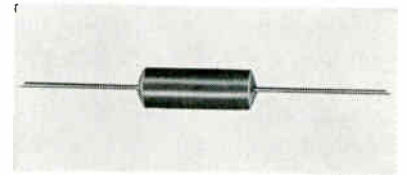
NPN Device Has 20-Watt Dissipation

PLANAR epitaxial power transistor recently announced by Fairchild Semiconductor, Div. of Fairchild Camera and Instrument, Syosset, New York, features 20 watts of d-c power dissipation at 100 C case temperature. Called the 2N2893, the transistor is packaged in a $\frac{1}{8}$ -inch hexagon configuration and has a guaranteed beta range between 50 and 150 at 2 amp.

The company says that the high

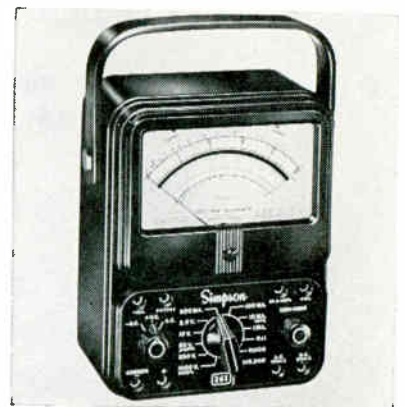
performance of this silicon unit is made possible by its interdigitated geometry that provides a maximum emitter area to collector base area ratio. Moreover, they state that the interdigitated, epitaxial construction lends itself to precise manufacturing process control, resulting in lower collector resistance and capacitance and thus increasing device speed. A similar unit, the 2N2892 has a beta of 30 to 90 at 2 amp and two others of the series, the 2N2891 (beta = 50 to 150 at 2 amp) and 2N2890 (beta = 30 to 90 at 2 amp) are available in JEDEC TO-5 packages.

These transistors are useful in audio power applications up to vhf frequencies, power converters, video drivers and other high-reliability circuits. They cost between \$35 and \$55 in lots of 100. (303)



Encapsulated Resistor With Axial Leads

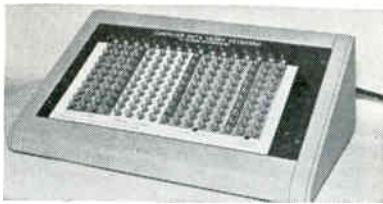
RESISTOR, type 7044, measuring $\frac{1}{2}$ -in. diameter by $\frac{1}{2}$ -in. long, offers 1 megohm, maximum resistance (utilizing 0.001 wire), 0.5 w maximum, 400 maximum volts. Wattage is rated at 25 C through 125 C. Type 7044 is non-inductive wound. RCL Electronics, Inc., One New Jersey Ave., Riverside, N. J. (304)



VOM Features High Accuracy

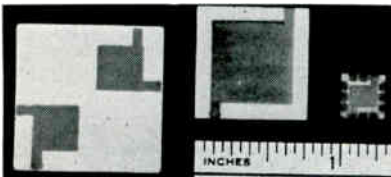
MODEL 261 volt-ohm-milliammeter offers accuracies of $\pm 1\frac{1}{2}$ percent

d-c, ± 3 percent a-c. It also features self-shielded annular meter movement (not influenced by outside magnetic fields; spring backed jewels (withstands more abuse due to shock and vibration without increasing frictional error); mirror scale—knife-edge pointer; diode overload protection (prevents movement burnout even on 200,000 percent overload). Price of model 261 is \$59.95; model 261RT (roll top), \$65.95. Simpson Electric Co., 5205 West Kinzie St., Chicago 44, Ill. (305)



Data-Entry Keyboard Used With Computers

A MORE ACCURATE and convenient method of entering large quantities of data into digital computers directly at the source has been introduced. The computer data-entry keyboard can be equipped with as many as 18 decades of lighted keys upon which an entire field of numeric data may be entered. The keys are electrically interlocked by decades and store the data field for visual verification prior to recording on punched paper tape. The self-contained desk-top key board employs highly reliable, solid-state electronic components to scan the fixed format data field and also provides automatic entry of certain prewired computer instructions, such as end of field and end of record codes. Colorado Instruments, Inc., Garden Office Center, Broomfield, Colo. (306)



Film Capacitor Has High Reliability

THIN-FILM screened capacitor, the Cerafer, has a capacitance range up to 8,000 pf per single layer per $\frac{1}{2}$ -in. square maximum size. Capacitance

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and Q remain constant throughout life and throughout processing temperatures up to 500 C for 15 minutes. Rating is 75 v d-c working and insulation resistance exceeds 100,000 megohms at 50 v d-c over -65 C to +125 C temperature range. Standard tolerances are ±10 percent over 25 pf and ±25 percent under 25 pf with special tolerances of ±2 percent and ±5 percent available at 50 pf and over. Cerafer capacitors are designed for applications involving micro or thin circuitry on flat alumina substrates. CTS Corp., Elkhart, Ind.

CIRCLE 307, READER SERVICE CARD



Resistor Tester Needs No Adjustment

AUTOMATIC resistor test instrument, model R105, tests nominal resistance value from 10 ohms to 11.999 megohms to an absolute accuracy of 0.1 percent, yet never needs adjustment. With simple dial-knob settings for the resistance and the desired tolerances, the R105 is handled by non-technical personnel after a few minutes orientation. Plus and minus tolerances are separately programmed from 0 to 10.9 percent in 0.1-percent steps. A "guard band" safety factor is introduced by a convenient plug-in module. Testing rate is approximately 80 millisecc per resistor. Manual handling is accomplished with a fast-loading clip which assures a sound four-probe contact for all resistors. Teradyne, Inc., 87 Summer St., Boston 10, Mass. (308)

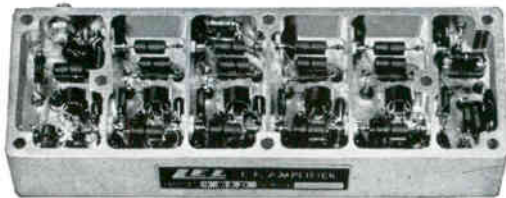
Recorder/Reproducer Has Six Speeds

ADVANCED r-f/predetection video recorder/reproducer, model L-4000, is announced. Tape speeds are 7½, 15, 30, 60, 120 and 180 ips. Wow and flutter: less than 0.2 percent peak-to-peak measuring components

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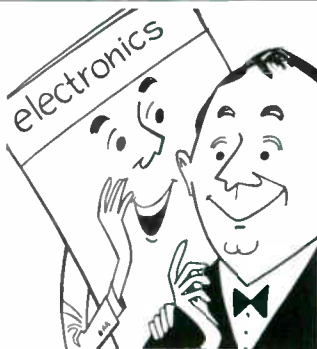
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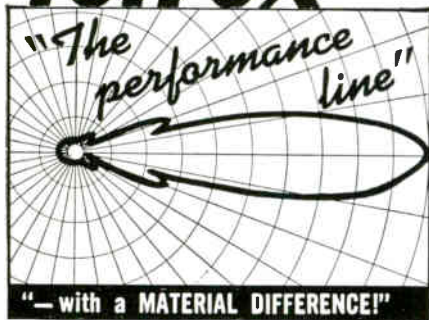
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Telrex



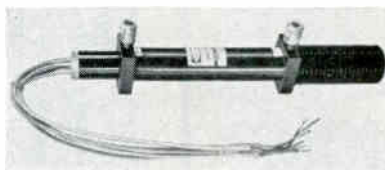
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Asbury Park 41, New Jersey, U.S.A.

from d-c to 10 Kc at 60 ips. Absolute time displacement error: ± 0.2 μ sec reference to a 100 Kc control tone at 60 ips. Reel and tape sizes: 10½ in. to 15 in. NAB reels, ½-in. or 1-in. wide tape. Frequency response: 800 cps to 2.225 Mc ± 3 db at 180 ips; 300 cps to 33.5 Kc ± 3 db at 7½ ips. Rise time: 0.22 μ sec at 180 ips; 5.28 μ sec at 7½ ips. Winston Research Corp., 6711 S. Sepulveda Blvd., Los Angeles 45, Calif.
CIRCLE 309, READER SERVICE CARD



Traveling Wave Tube Offers Compactness

COMPACT traveling wave tube that boosts energy output for missile and airborne use has been developed. Only 3 lb in weight and 12½ in. long, the rugged metal ceramic type QKW 1023 tube delivers a minimum 10 w continuous wave power output. It operates in the 4 to 8-Gc frequency range. Tube features ppm focusing. This helps reduce tube size and weight as well as magnetic field interference problems. It also eliminates the need for external mounts. Raytheon Co., Microwave and Power Tube division, Foundry Ave., Waltham 54, Mass. (310)

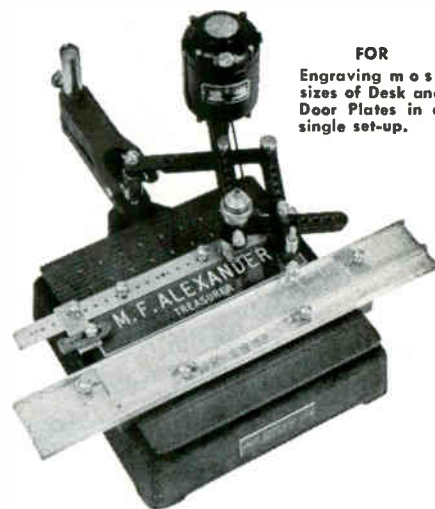


Component Oven Operates at 75 C \pm 2 C

COMPONENT oven V1077 has a capacity sufficient for one 1½- by 3½-in. circuit board. Dimensions are 1½ by 1½ by 4 in., excluding studs and header. Operating temperature is 75 C \pm 2 C. Stability is ± 4 C over an ambient temperature range of

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3. Uses standard tapered-shank engraving cutters.
4. New 19" Copy carriers hold 17" of master copy: Permits engraving about 11" line of characters in one set-up at the 1.5:1 ratio.
5. Three sizes of copy carriers available. Each positioned separately.
6. Work-holding fence speeds set-up and engraving time.

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We stock all sizes, all shapes, all grades, for all uses... all ready for 24-HOUR DELIVERY. Also magnets engineered and fabricated to your needs.

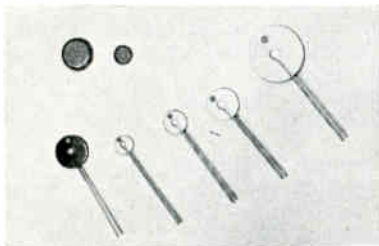
PERMAG PACIFIC CORP. 6178 W. Jefferson Blvd. Los Angeles 16, Calif. / Phone: Area Code 213 VErmont 7-4479 / TWX: 213 836-0445

PERMAG CENTRAL CORP. 5301 D Otto Ave. Rosemont, Des Plaines, Illinois / Phone: Area Code 312 678-1120

PERMAG CORP. 88-06 Van Wyck Expressway Jamaica 18, New York / Phone: Area Code 212 OLympia 7-1818 / TWX: 212 479-3654

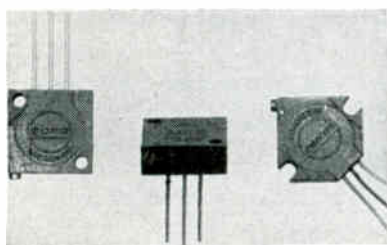
CIRCLE 206 ON READER SERVICE CARD

-55 C to 65 C. Power requirements: 20 watts at 110 volts a-c. Specifications may be modified to suit user's requirements. Reeves-Hoffman Division of Dynamics Corp. of America, Cherry and North Streets, Carlisle, Pa. (311)



Silicon Varistors Are Low Voltage Type

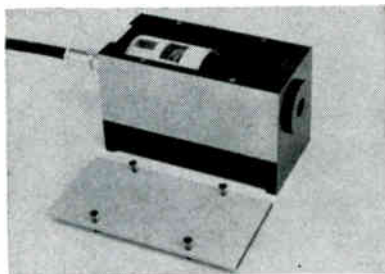
SERIES of low voltage varistors are made of silicon carbide mixed with ceramic binders, molded and fired at high temperatures. Classified in 10 current ranges at voltages of 12, 24 and 48 volts, the varistors are available in $\frac{1}{4}$, $\frac{1}{2}$, 1 and 3 watt sizes as flat disks with metal sprayed faces or with tinned leads and dip coated. The Carbone Corp., P. O. Box 89, Boonton 2, N. J. (312)



Trimming Pots Are Wirewound

NEW $\frac{3}{8}$ in. and $\frac{1}{2}$ in. square wirewound trimming potentiometers which are humidity-proof, dust-proof, and shock-proof to 100 g, have been developed. They operate from -65 C to +175 C. Resistance ranges from 10 to 100,000 ohms with ± 5 percent standard tolerance for the $\frac{1}{2}$ -in. model and 10 to 50,000 ohms, ± 5 percent standard tolerance for the $\frac{3}{8}$ -in. trimmer. The $\frac{1}{2}$ -in. power rating is 1 w at 70 C, and the $\frac{3}{8}$ in. is 1 w at 50 C—both are derated to 0 w at 175 C. Resolution of adjustment is 1.0 percent to 0.084 percent; mechanical adjustment—25 turns nominal. Temperature coefficient is 50 ppm/deg C

nominal. Borg Equipment, a division of Amphenol-Borg Electronics Corp., Janesville, Wis. (313)



Laser Detector Is Power Sensitive

MODEL K-D1 detector is a power-sensitive photon radiation transducer for measuring and monitoring laser output and the output of other light sources. Device has a rise time of 0.3 nsec. Absolute power measurements from 1 w to 10^{10} w, and energy measurements from 10^{-8} to 10^3 joules are typical. Unit is available with either an S-20, S-4 or S-1 photo-surface; these three different surfaces provide a spectral response range from 3,000 to 11,500 angstroms. Korad Corp., 2520 Colorado Ave., Santa Monica, Calif. (314)



Miniature Amplifier Features Low Noise

GENERAL-PURPOSE low noise amplifier, model 206, provides selection of three fixed gain settings of 10, 100 and 1000 at bandwidths of 1 Mc, 650 Kc and 500 Kc respectively. Max output is rated at 3 v rms and distortion is less than 1 percent at max rated output. Equivalent input noise for full bandwidth (input shorted) is less than 10, 7 and 6 μ v for gains of 10, 100 and 1,000, respectively. Typical narrowband noise voltage is 5×10^{-9} v per root cycle, and noise current 3×10^{-12} amperes per root cycle above 1 Kc. Instrument is packaged in a cabinet measuring 4 in. by 7 in. by 6 in. including all controls. Quan-Tech Laboratories, Inc., Boonton, New Jersey. (315)

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on-time delivery of emergency

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1 to 5 Reeds
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Wire sizes #6 to #56, Classes A, B, F and H. Complete engineering service available.

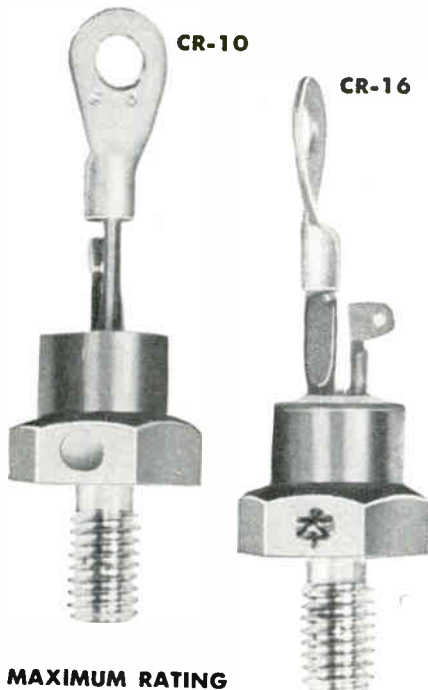
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COTO-COIL COMPANY INC.

65 Pavilion Avenue, Providence 5, R. I.

Origin

Silicon Controlled Rectifier



MAXIMUM RATING

TYPE Specification	CR-16A CR-10A	CR-16H CR-10H	Units
Peak Voltage (Reverse biased)	25	~ 400	V
Peak Blocking Forward Voltage	25	~ 400	V
A.C. Input Voltage	17.5 ~ 280		VRMS
Average Forward Current	(CR-10) 10	(CR-16) 16 (Ta = +20°C)	A
Surge Current	(CR-10) 100	(CR-16) 130	A
Peak Gate Power	5		W
Average Gate Power	0.5		W
Peak Gate Current	2		A
Peak Gate Voltage (Forward)	10		V
Peak Gate Voltage (Reverse)	5		V
Junction Temperature	100		°C
Storage Temperature	-40 ~ +125		°C

Main Products:

Semi-conductors, condenser type spot welder, synthetic enamel and miniature ball bearing.

ORIGIN ELECTRIC COMPANY LTD.



1-195 Takadaminami-cho, Toshima-ku, Tokyo, Japan

Cable Address: "ORIGINELE TOKYO"

Literature of the Week

DRUM MEMORIES Vermont Research Corp., P.O. Box 498, Springfield, Vt. Brochure describes two series of magnetic drum memories with data on information storage and retrieval.

CIRCLE 316, READER SERVICE CARD

CENTER BONDED MOUNTINGS Lord Mfg. Co., Erie, Pa. Bulletin 712 describes design, performance features and typical applications for center bonded mountings. (317)

D-C POWER MODULES Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif. Bulletin PS363 describes ResisTran high current d-c power modules. (318)

OPTICAL METER RELAY Assembly Products, Inc., Chesterland, O. Bulletin 33-A covers an optical meter relay that features contactless control with continuous indication through fiber optics and solid-state electronics. (319)

RELAY ASSEMBLIES C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Ill. Data sheet 551 contains a description of two sizes of type J DP direct plug-in telephone-type relay assemblies. (320)

THERMISTORS FOR FLOW MEASUREMENT Victory Engineering Corp., 122-48 Springfield Ave., Springfield, N. J. Publication V-1136 gives complete background and application information on flow metering with thermistors. (321)

POWER KLYSTRONS Varian Associates, 611 Hansen Way, Palo Alto, Calif., is offering a booklet written for engineers and technicians who operate and maintain equipment using power klystrons. (322)

PORTABLE INDICATING INSTRUMENTS Westinghouse Scientific Equipment Department, P.O. Box 868, Pittsburgh 30, Pa. Bulletin 99-352 describes a line of portable indicating instruments with taut-band suspension. (323)

AUTOMATIC TEST INSTRUMENTS Tera-dyne, Inc., 87 Summer St., Boston 10, Mass. Brochure describes the characteristics of a broad range of easily programmed automatic test instruments for electronic components. (324)

PACKAGED BLOWERS McLean Engineering Laboratories, P.O. Box 228, Princeton, N. J. A broadly expanded line of Mil-Spec packaged blowers for electronic rack cooling is presented in an eight-page catalog. (325)

CONNECTORS AND HEADERS Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Bulletin describes hermetically sealed connectors and headers designed for maximum resistance to radiation, high temperature, thermal shock, and corrosive environments. (326)

ELECTRONIC MEDICAL SYSTEMS Honeywell Electronic Medical Systems, 4800 E. Dry Creek Road, Denver 10, Colo. A condensed catalog contains information on various types of electronic medical systems. (327)

NICKEL CADMIUM BATTERIES Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., offers a brochure on its nickel cadmium rechargeable batteries. (328)

MICROWAVE ANTENNAS Lenkurt Electric Co., Inc., San Carlos, Calif. Volume 12, No. 5 of the *Demodulator* contains Part One of a series of articles on antenna systems for microwave. (329)

MICROWAVE COMPONENTS Airtron, 200 E. Hanover Ave., Morris Plains, N. J. The first 12 data sheets for what will be a complete catalog of microwave components are now available. (330)

STANDARD QUARTZ & PYREX ACCESSORIES General Technology Corp., 3510 Torrance Blvd., Torrance, Calif. Bulletin 7100 describes standard quartz and pyrex accessories employed by the semiconductor industry in diffusion, doping and heat treating operations. (331)

PULSE GENERATOR Texas Instruments Incorporated, 3609 Buffalo Speedway, Houston, Texas. Bulletin D602 describes ten pulse shaping modules including specifications and oscilloscope photographs of output waveforms. (332)

MICROWAVE DIODES Alpha Microwave, Inc., 381 Elliot St., Newton Upper Falls 64, Mass., offers literature describing its line of ceramic cartridge and subminiature glass microwave mixer and video detector diodes. (333)

COMPLEX TRANSFORMATION RATIO DETERMINATION North Atlantic Industries, Inc., Terminal Drive, Plainview, N. Y. Technical bulletin TB-105 now available describes the measurement of complex transformation ratios by phase sensitive nulling techniques. (334)

DIFFUSION FURNACES Electroglas, Inc., 841 Warrington Ave., Redwood City, Calif., has available literature describing capacity, performance and full operating specifications on diffusion furnaces for semiconductor processing. (335)

PRECISION RESISTORS Marstan Electronics Corp., 204 Babylon Turnpike, Roosevelt, N. Y., has available a new edition of the precision resistor catalog referencing changes in the new Mil spec. (336)

BEAM POWER PENTODE TUBE Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J., announces publication of a 4-page product bulletin on the type 8149 beam power vhf pentode tube. (337)



**Are you a
COMPLETELY INFORMED
electronics engineer?**

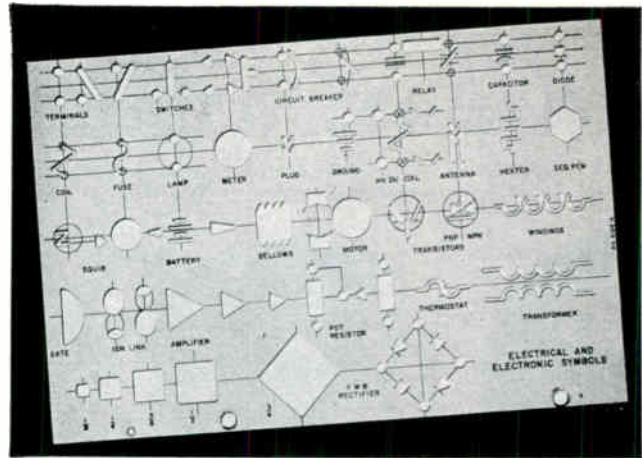
Today you may be working in microwaves. But on what project will you be working tomorrow? You *could* have read **electronics** this past year and kept abreast of, say, microwave technology. *There were 96 individual microwave articles between July, 1961 and June, 1962!*

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Counting knob

**Zivy
Z 1003**



for mounting on precision multiturn potentiometers, controls of precision instruments, machine tools, etc.

Read to 1/500 of a turn

Estimate 1/1000th

Write to:

Victor George Herman
49 West 96th Street
New York 25, N.Y.

Motorola Names Three Managers



R. Peth



J. F. Mitchell



D. R. Jones

MOTOROLA'S Communications division in Chicago has named Robert Peth, John F. Mitchell and Donald R. Jones to new positions.

According to vice-president William J. Weisz, each man has full responsibility for the design, development, production, marketing and sale of the products assigned to him.

Peth has been appointed manager of mobile communications products, and is assigned mobile two-way radio communications equipment, including mobile units, base, stations, and control equipment. He was most recently manager of engineering for mobile and portable communications products.

Mitchell has been named manager of portable communications products in charge of portable two-way radio products. He was formerly chief engineer of mobile and portable communications products.

Jones has been appointed manager of signalling products. Before his promotion, he was manager of marketing for mobile and portable communications products.

Hughes Aircraft Appoints White

C. E. WHITE has been appointed manager, administration and material of the Hughes Aircraft Company's ground systems group in Fullerton, Calif.

White's responsibilities will in-

clude supervision of the following departments: industrial relations and services, management operations, information media, and material services staff. He will also direct the operations of the material organizations which service engineering, manufacturing, and communications.

Prior to his current appointment, White was manager for administration at ground systems group.



Indiana General Appoints Smith

APPOINTMENT of Gerald Smith as general manager of the newly created Memory Systems division of Indiana General Corp., Valparaiso, Ind., has been announced. Until now the engineering, manufacture and sale of Indiana General Corporation's memory systems have been part of the company's Electronics division.

Before joining Indiana General,

Smith was director of research and development of the Military Electronics division of Daystrom, Inc.

Von Harz Accepts IRC Position

JAMES L. VON HARZ has joined International Resistance Co. as general manager of the Burlington (Iowa) division.

Von Harz was administrative vice president at Oak Mfg. Co. when he terminated his affiliation with that firm after 21 years of service. Immediately prior to joining IRC, he was vice president of Waller Corp.



Honeywell Promotes Edward Lund

APPOINTMENT of Edward C. Lund as vice president and general manager of Honeywell's Ordnance division has been announced. In this position he is responsible for Ordnance division plants in Hopkins and New Brighton, Minn., employing some 5,200 persons, and plants in West Covina, Calif., and Seattle, Wash., with a total of approximately 1,000 employees.

Lund was formerly general manager in charge of Minneapolis Ordnance operations.

Raybuck Advances to Vice President

CHARLES B. RAYBUCK has been made vice president for engineering at Melpar, Inc., Falls Church, Va. He joined Melpar in 1951 as assistant

THIS TAPE RECORDER SELDOM SPINS ITS REELS

Instead of keeping its reels in motion, this new digital recorder operates incrementally. It stands still awaiting the arrival of each character, records it, then moves the tape a uniform distance to await the next. Though digital characters may

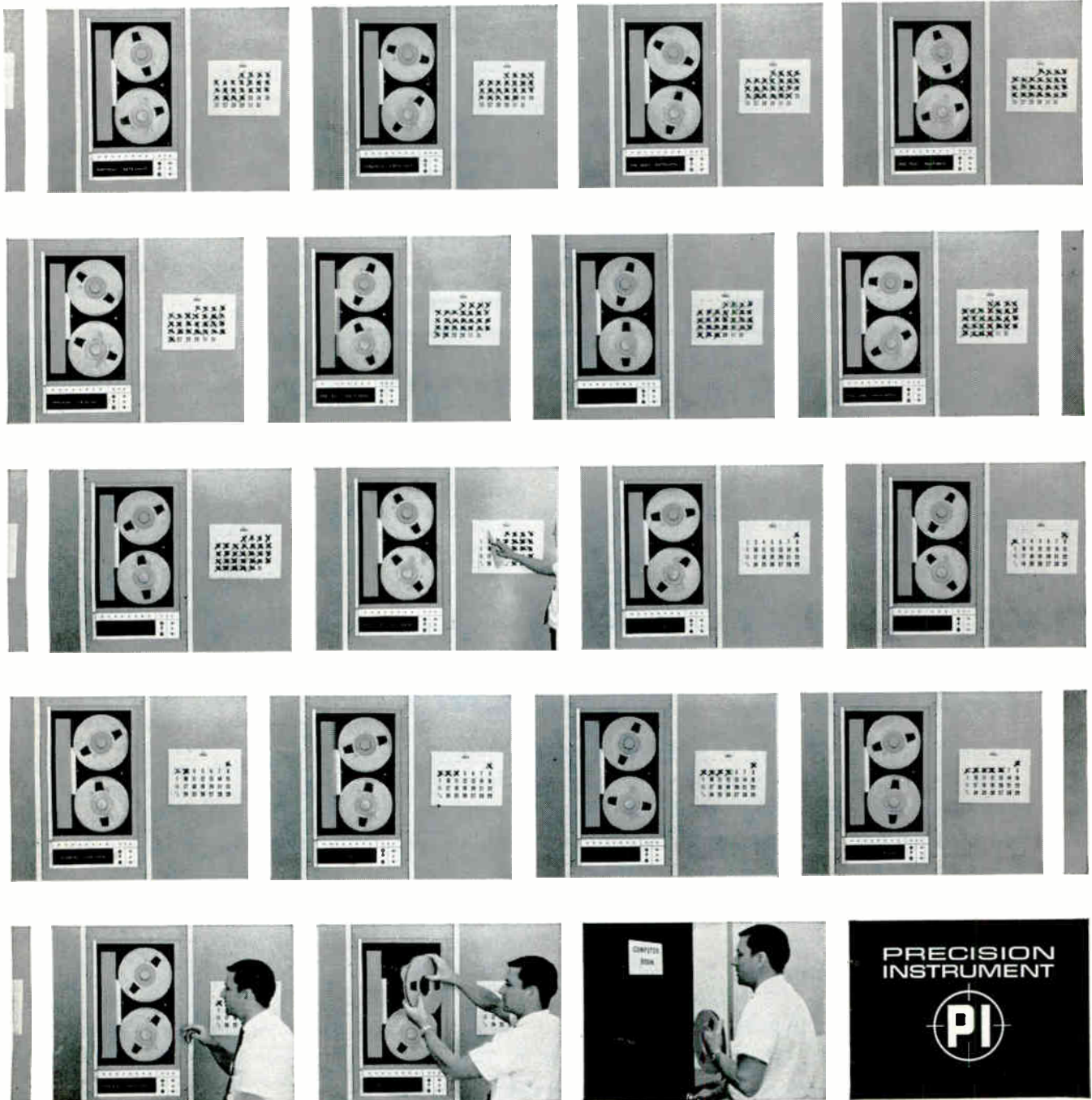
a r r i v e l i k e t h i s

The PI incremental recorder assembles them, bit by bit, like this

 on the tape, ready for computer entry. The format is fully compatible with IBM, CDC, and other computer input requirements.

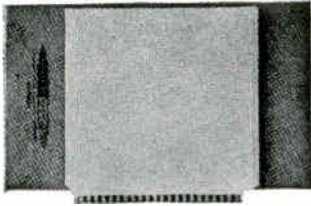
Whether characters arrive irregularly or synchronously, once a month or 150 times a second — from such sources as a teletypewriter or analog-to-digital converter — they are now recorded in a proper, uniform packing density of 200 BPI (556 optional). Punched cards, paper tape, or other forms of intermediate data storage are eliminated.

To tell you more, we've assembled some 86,000 bits of information on the RSL-150 incremental recorder. They space out nicely into a 6-page brochure, a copy of which is yours for the asking. Address us at **Stanford Industrial Park, Palo Alto 20, California.**



NEW MINIATURE DELAY LINES

¼ CU. INCH PER μSEC.



Total delay of 24.65 μsec. in a 4½" x 4" package



- Total weight: 8½ oz.
- Total delay accuracy better than ½ of 1%
- Total delay to rise time ratio better than 40:1
- Distortion under 4%
- Temp. coefficient: 50 ppm ± 20 ppm/°C

WRITE FOR DETAILS
Opening exists for a Delay Line Design Engineer

ADMIRAL PALO ALTO

Palo Alto Division of Admiral Corporation
Stanford Industrial Park, Palo Alto, California

CIRCLE 84 ON READER SERVICE CARD

WHEATSTONE BRIDGE



**±0.1%
ACCURACY**

Model L-3C

Range: .001Ω to 11.11 MΩ
Rheostat Arm: 1Ωx10+10Ωx10+100Ω
x10+1000Ωx10 (4 dials)
Ratio Arm: x0.001, x0.01, x0.1, x1
x10, x100, x1000
Overall Accuracy: 100Ω to 100kΩ ±0.1%
10Ω to 1MΩ ±0.3%
1Ω to 10MΩ ±0.6%

Accurate resistance measurement achieved with a single unit. No accessories, no power source required. Operates on three type D, 1.5V dry cells, YEW's new, rugged galvanometer, Model G-2(B) incorporated. All 5 dials make no-rubbing contact and are dust-proofed, housed in individual plastic case. The L-3C has elastic mold unbreakable housing. Size: 7¼" x 9" x 5" Weight: 5 lbs. shipping weight: 10 lbs. Available for immediate delivery.
Cat No. 52402 \$156.00

CONFIDENCE BEGINS WITH YEW

YOKOGAWA ELECTRIC WORKS, INC.

40 WORTH STREET NEW YORK 13, N. Y.
Area Code 212 Telephone: BEekman 3-6720

CIRCLE 209 ON READER SERVICE CARD

chief engineer. He was elected an officer of the corporation in 1954 and until recently was in charge of contract management.

In his new position Raybuck has charge of four major organizational elements in the company: the electronics division, the Aerospace division, the Special Products division, and the Field Service department, as well as the necessary supporting activities.

PEOPLE IN BRIEF

Walter G. Wade, formerly with Bowles Engineering Corp., appointed chief scientist of Washington Technological Associates. **Geoffrey C. Winkler** promoted to director of mfg. for Huggins Laboratories, Inc. **James M. McCarty** advances to mgr. of engineering, West Coast operations, of the Perkin-Elmer Corp. **Warren R. Barton** leaves Consolidated Vacuum Corp. to join Bendix-Balzars Vacuum Inc. as director of mfg. **Martin H. Bloom**, previously associated with Brooklyn Polytech, named technical asst. to the president of General Applied Science Laboratories, Inc. **William J. Hammond** moves up at Claud S. Gordon Co. to asst. g-m and marketing mgr. **L. A. Caldwell** promoted to g-m of Admiral Corp.-San Diego div. **Northrup** ups **James M. Ricketts** to operations mgr. at the Nortronics systems support dept. **Henry H. Eichel**, USAF Ret., joins Space Technology Laboratories in program management capacity. **Dalmo Victor Co.** upgrades **Roy A. Hundley** to mgr., mechanical and servo engineering dept. **Robert N. Palmer** advances to applications engineering mgr., R&D, of the Tube div. of Varian Associates. **A. J. Critchlow** leaves GE to rejoin IBM as mgr. of innovation products technology. **Robert W. Jennings** moves up at Ampex Corp. to mfg. mgr. of the video and instrumentation div. **Arthur A. Turner**, g-m of The Carborundum Co. Refractories and Electronics div., elected a v-p of the company.

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.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
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Subject to Agency Commission.

Send **NEW ADS** to **CLASSIFIED ADV. DIV.** of **ELECTRONICS**, P.O. Box 12, N. Y. 36, N. Y.

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

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A metropolitan university is seeking an electronics engineer (M.S. preferred) with three years experience in magnetic thin-films and a good knowledge of circuits, to work in one of its Research Laboratories on a long-term computer-oriented applications program. Individual should be capable of working independently, and directing small group.

New York City Location

University Benefits

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P-2595, Electronics

Classified Adv. Div., P.O. Box 12, New York, N. Y. 10036

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).

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BELL AEROSYSTEMS CO. Div. of Bell Aerospace Corporation A Textron Company Buffalo, New York	86	2
GENERAL DYNAMICS/ELECTRONICS Military Products Div. San Diego, California	87	3
HEWLETT-PACKARD CO. 1501 Page Mill Rd. Palo Alto, California	77*	4
INDUSTRIAL DEVICES INC. Edgewater B, N. J.	86	5
LOCKHEED MISSILES & SPACE CO. Div. of Lockheed Aircraft Corp. Sunnyvale, California	75*	6
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick AFB, Fla.	79*	7
U.S.A.F AIR FORCE LOGISTICS COMMAND Joint Professional Placement Office New York, N. Y.	71*	8
P 2595	84	9

* These advertisements appeared in the July 26, 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)

8263

- | | | |
|--|--|---------------------------------------|
| <input type="checkbox"/> Aerospace | <input type="checkbox"/> Fire Control | <input type="checkbox"/> Radar |
| <input type="checkbox"/> Antennas | <input type="checkbox"/> Human Factors | <input type="checkbox"/> Radio—TV |
| <input type="checkbox"/> ASW | <input type="checkbox"/> Infrared | <input type="checkbox"/> Simulators |
| <input type="checkbox"/> Circuits | <input type="checkbox"/> Instrumentation | <input type="checkbox"/> Solid State |
| <input type="checkbox"/> Communications | <input type="checkbox"/> Medicine | <input type="checkbox"/> Telemetry |
| <input type="checkbox"/> Components | <input type="checkbox"/> Microwave | <input type="checkbox"/> Transformers |
| <input type="checkbox"/> Computers | <input type="checkbox"/> Navigation | <input type="checkbox"/> Other |
| <input type="checkbox"/> ECM | <input type="checkbox"/> Operations Research | <input type="checkbox"/> |
| <input type="checkbox"/> Electron Tubes | <input type="checkbox"/> Optics | <input type="checkbox"/> |
| <input type="checkbox"/> Engineering Writing | <input type="checkbox"/> Packaging | <input type="checkbox"/> |

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

ENGINEERS... PHYSICISTS...

Can Your Professional Growth Keep Pace with Bell's Growth in Electronics?

**Avionics Division Shows
600% Sales Increase in Past 5 Years**

If you are not certain how far your present position can take you, you may wish to consider a position with the Avionics Division of Bell Aerosystems Company.

This division is growing—and expects to continue—as a result of trail-breaking engineering concepts and performance in inertial guidance (a Bell digital velocity meter triggered the Mariner mid-course correction), and automatic landing systems (Bell's all-weather, automatic aircraft landing system can touch down 2 planes a minute even in dense fog).

Current contractual work involves controls for a lunar landing research vehicle, digital-to-voice converters, digital tie-in equipment and computers, sighting devices, exotic instruments, battlefield air traffic controls, learning machines, high precision gyroscopes and accelerometers, target locator systems, navigation systems, mapping systems and automatic landing systems.

To assure Bell's continuing progress and expansion in the electronics area, a few senior positions are available for experienced men interested in making significant contributions in the following areas:

ADVANCED SYSTEMS ANALYSIS

Responsibility for analytical investigations associated with modern weapon systems involving problems in areas of fire control, guidance, radar, and communication systems using digital and analog computing facilities when required. Advanced degree in physics, engineering or math with minimum 8 years related experience required, of which 4 must be in one of the above specific areas. Salary to \$18,000.

ADVANCED SYSTEMS DESIGN

Responsibility for analytical and preliminary design studies of command and control systems for terrestrial and orbital vehicles. Specific areas of investigation include position determination, vehicle control, data processing and transmission, and information display. Advanced degree in physics or EE with minimum 8 years related experience required, plus knowledge of military system design requirements. Salary to \$18,000.

AIR TRAFFIC CONTROL SYSTEMS

Perform studies of advanced air traffic control problems, define system requirements, investigate various approaches to problem solution, perform analytical work to support system feasibility, optimize system performance, suggest means for reduction to practice, act as consultant in the fabrication of feasibility hardware. Advanced degree in EE or physics with minimum 5 years related experience in one or more of the following: radar systems engineering, closed loop control, aerospace vehicle dynamics, operation analysis. Salary to \$18,000.

ADVANCED RESEARCH & DEVELOPMENT

Responsibility for determination of fruitful areas of research for advancing the state of the art, conducting original studies (both analytical and experimental), and acting as consultant in other communication and radar problems. An advanced degree in physics or EE with a communications specialty is required, plus the analytical ability to recognize problem areas, and the conceptual ability to determine solutions. Salary to \$18,000.

SOLID STATE PHYSICS

Form and head up group to perform research and development in solid state to further basic physical solid state phenomena towards practical application in avionics systems. MS or PhD in physics required with experience in one or more of the following: stimulated emission of radiation, semiconductor devices, solid state devices for information storage and retrieval. Salary to \$18,000.

INERTIAL SYSTEMS

Responsibility for inertial systems synthesis and analysis, including application to existing government requirements; and to establish new requirements, analyze existing systems and develop and apply new ideas in the field, including analysis of hybrid systems. Advanced degree in EE, physics or math with minimum 10 years related experience, 5 years of which must have been in inertial navigation. Salary to \$18,000.



Resumes are invited from qualified men.
Please address Mr. Thomas Fritsch, Dept. G-24.

BELL AEROSYSTEMS CO.

DIVISION OF BELL AEROSPACE CORPORATION—A **Textron** COMPANY

An Equal Opportunity Employer P.O. Box #1, Buffalo 5, New York

ENGINEERS

An Unusual Opportunity
in Northern N. J.

For the creative engineer, with E.E. degree or equivalent, able to work with minimum supervision on the development of new electro-mechanical products—an opportunity to enjoy design freedom and complete responsibility, and to determine the future unhampered by the inertia of a large organization.

We manufacture indicator lights, switches, and molded plastic components for the electronic and electrical industries, and have enjoyed steady rapid growth based on solid industrial business—relatively unaffected by the "boom or bust" military pattern.

We are prepared to offer immediate status within our organization and rewards commensurate with results. The future is dependent only upon performance.

Send your resume today to Nathan Schnoll, President

INDUSTRIAL DEVICES, INC.

Edgewater 8, New Jersey

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"ALFA" V.O.M.'s Made in Belgium. We should like to appoint Distributors in USA for the famous ALFA V.O.M.'s, competitive in the international market—beautiful and precise instruments. For conditions and quotations please write to: Societe Industrielle Alfa, S.A., 80, rue de la Senne, Brussels-Belgium. Tel.: 12-67-30 (5 lines). Telex: 2-21844.

(Additional Employment Opportunity
Advertisement on page 84)

SEARCHLIGHT SECTION

(Classified Advertising)

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EQUIPMENT - USED or RESALE

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The advertising rate is \$27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured $\frac{1}{8}$ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

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RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 950 ON READER SERVICE CARD

**LOOKING FOR
USED/SURPLUS ELECTRONIC
EQUIPMENT/COMPONENTS?**

For an up-to-date listing of such equipment see Searchlight Section of July 12th Issue.

BREAKING THE TIME BARRIER



Although Rome wasn't built in a day, much less 137 days, the General Dynamics/Electronics SC-760 was. In fact, this highly versatile two-way doppler tracking system was "idea-ed" and delivered within this astonishingly short span of time.

A four and a half month wonder when you consider that our engineers and scientists produced it from scratch and that it is now gathering highly accurate rate information—in digital data form—on cooperative missiles launched from the Pacific Missile Range. Its exceptionally reliable, solid-state phase-lock receiver is highly sensitive—operating at signal levels as low as -151 dbm.

This tracking colossus is just one example of the work being done at General Dynamics/Electronics. Whatever the phase of electronic and communication systems or however complex, our engineers and scientists are busily pushing aside many grey areas in pattern recognition studies, speech analysis, bandwidth compression, single sideband communications, underwater detection systems and in digital communications. Above all, they are creating technology on the move. And...their careers move, too.

Right now an interdisciplinary team is designing and building the equipment to test the most sophisticated electronic equipment for the most advanced tactical aircraft under development today. Each man on the team is becoming thoroughly familiar with a wide sampling

of commercial hardware designed by leaders in their respective fields.

There are openings on this team for graduate EE's with design experience in space communications, RF circuitry, tracking equipment, advanced pulse circuitry, mobile communication sets, doppler systems, navigation aids, reconnaissance/countermeasures, USW/ASW equipment, aerospace ground equipment, IFF equipment and telemetry receivers and transducers.

Additional positions are available in the Space Electronics & Navigation Laboratory where the SC-760 was created. In-house contracts can provide assignments for RF circuit design engineers on TACAN navigation systems (both airborne and ground equipment), advanced telemetry and tracking receiver design, and Doppler and monopulse tracking systems.

While the nature of the work is a star attraction at General Dynamics/Electronics, the Company location provides another source of satisfaction. Rochester, New York has the largest percentage of professional people in the nation for a city in the 500,000 population class...is noted for its cultural and educational advantages, and its proximity to the recreational and vacation areas on Lake Ontario, the Finger Lakes and the Adirondack Mountains.

If you would like to join this professional community within a professional community, send a resume to R. W. Holmes, registered engineer, Dept. 22.



GENERAL DYNAMICS | ELECTRONICS

An Equal Opportunity Employer

1400 N. GOODMAN ST., ROCHESTER 1, N. Y.

GD/E

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• See advertisement in the July 25, 1963 issue of Electronics Buyers' Guide for complete line of products or services.

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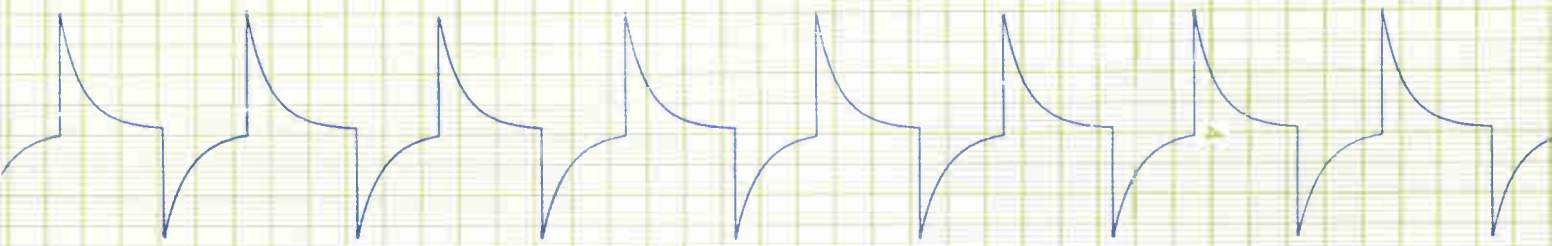
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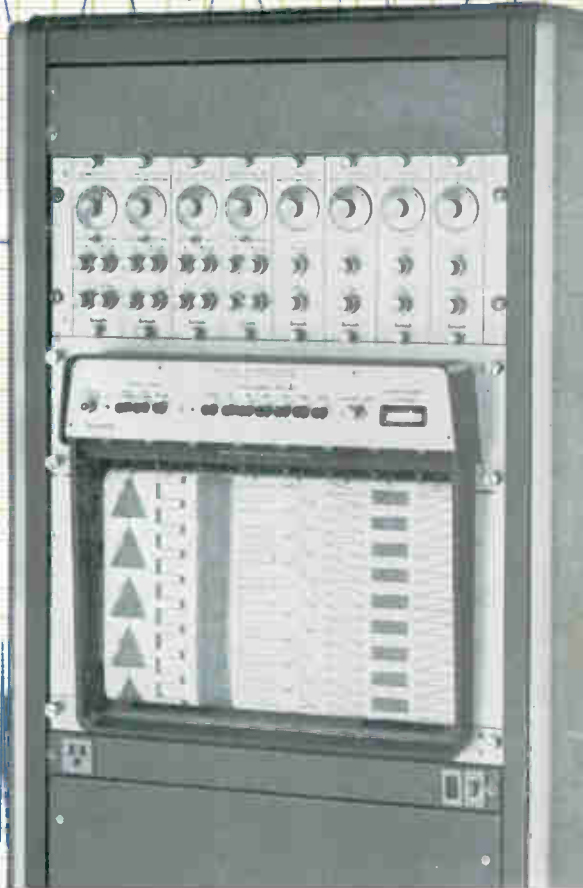
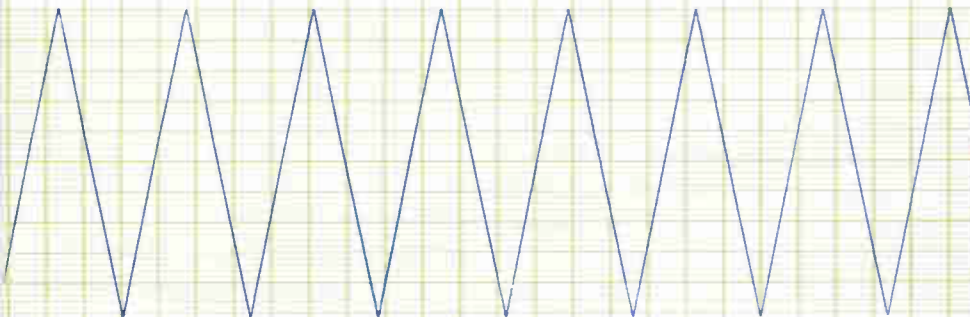
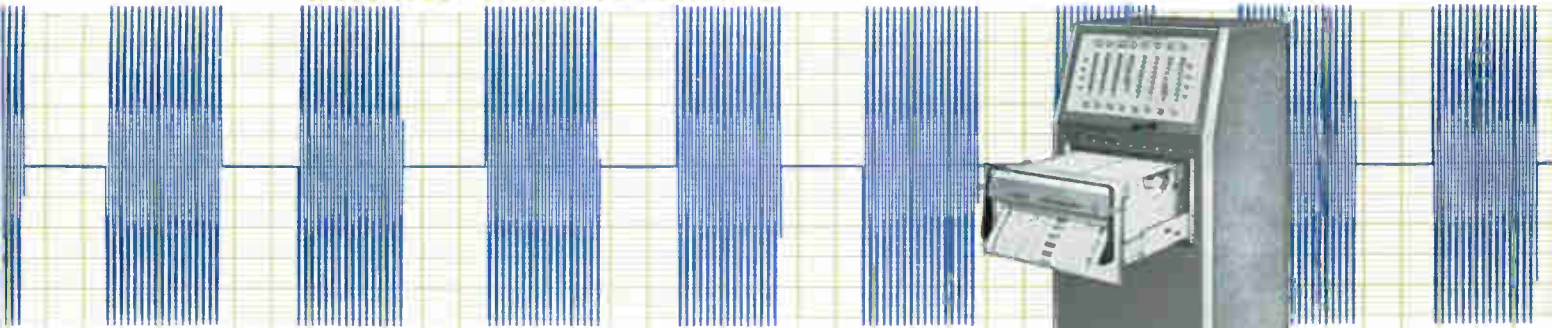


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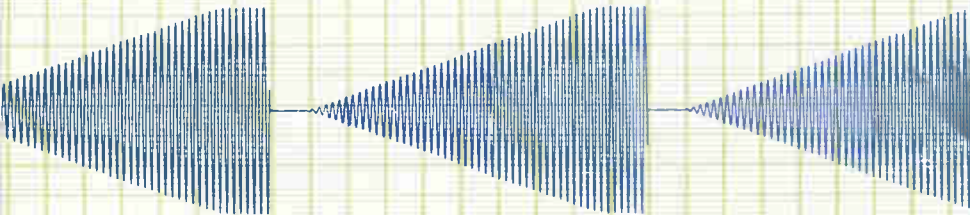
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The new **Brush Recorder Mark 200** made these incredibly crisp tracings. No other recorder in existence can match them. Note the line width. It never varies . . . regardless of writing velocity, regardless of chart speed. The writing mechanism is electrically signaled by the position-seeking "Metrisite" transducer . . . no parts to wear, infinite resolution, verifiable dynamic $\frac{1}{2}\%$ accuracy. Traces are permanent, high-contrast, reproducible . . . on low cost chart paper. The Mark 200 has but three standard controls . . . attenuator, pen position, chart speed. Such fidelity, simplicity and economy are possible with no other direct writing recorder. Available in both vertical and horizontal models with interchangeable plug-in preamplifiers or signal conditioning push-button controls. Write for details . . . they'll speak for themselves.

CIRCLE 901 ON READER SERVICE CARD

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Why Wurlitzer chose
the RCA-7868 NOVAR Power Pentode
for its Electronic Pianos



**“High Power Sensitivity, High Power Output Capabilities
and Low Cost”...**

THE WURLITZER COMPANY



This is the power amplifier stage of the new Wurlitzer Console Electronic Piano, *first mass-produced instrument of its kind on the market.* The two power pentodes are RCA-7868 novar types. Why did Wurlitzer engineers choose novar tubes?

Because:

- “The RCA-7868 offers high power sensitivity, high power output capabilities and low cost.”
- “Comparative tests were run on other tubes with equal results from the standpoint of distortion at power outputs of 20 and 30 watts, but the novar tube provided the desired performance at reduced cost.”
- “In addition to supplying the required power at lower cost than other types, the novar 7868 also permitted us to ship the instruments with the tubes in their sockets without special mounting clamps or packing materials.”
- “The compactness of the tube permitted us to install it in amplifiers where vertical clearance is limited.”
- “Novar construction permits more efficient heat conduc-

tion through the base pins to the sockets and the chassis, thus transferring heat from the tube bulb to a greater cooling area.”

The RCA-7868 supplies 25 and 35 watts of audio power in Wurlitzer Model 4100 and 4430 electronic organs respectively, and 15 watts of audio power in the Wurlitzer console electronic piano.

The unique design features that made these novar types a wise choice for Wurlitzer may also be the answer to *your* circuit design problem. For more information on novar tube types, see your RCA Field Representative or write Commercial Engineering, Section H-19-DE-1, RCA Electronic Components and Devices, Harrison, N. J.

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