November 3, 1961

electronics

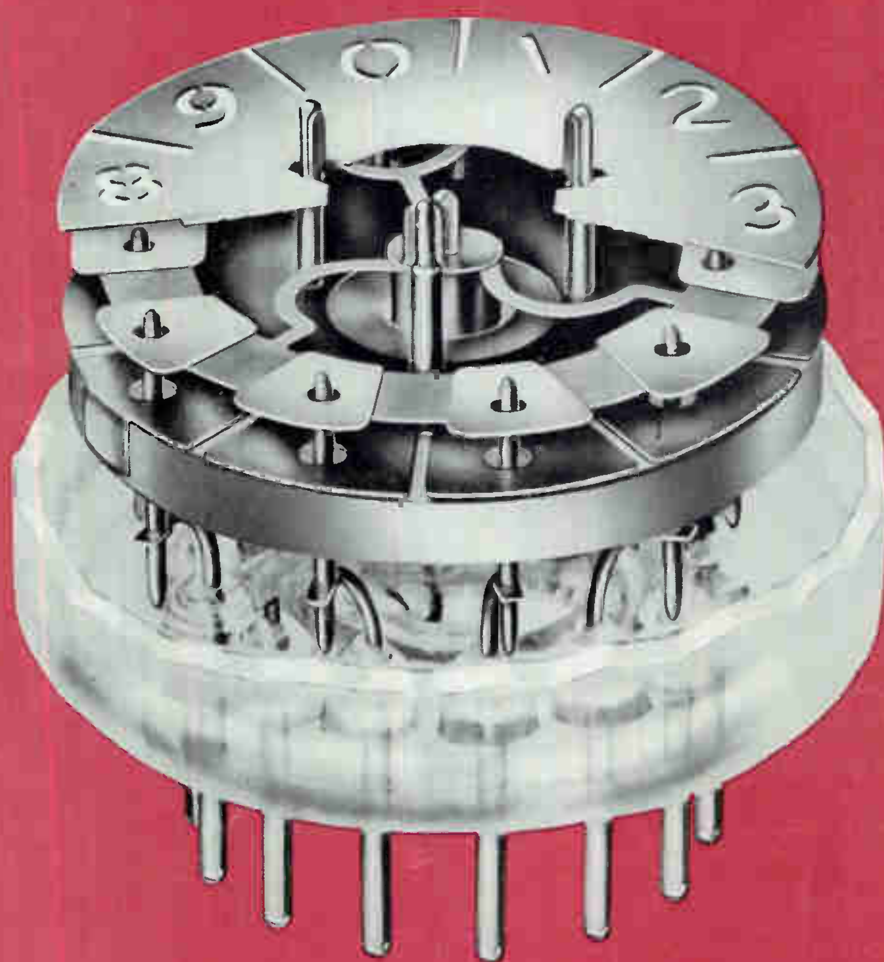
A McGraw-Hill Publication 75 Cents

DESIGNING BY COMPUTER

It derives circuit charts, *p 48*

JELLY-ROLL HORN

Compact X-band antenna, *p 38*



LOW-LEVEL COUNTER

(above) Driven by transistors, *p 60*

PHOTOGRAPHING LIGHTNING... IN THE SKY

Using G-R's Pulse, Sweep, and Time-Delay Generator

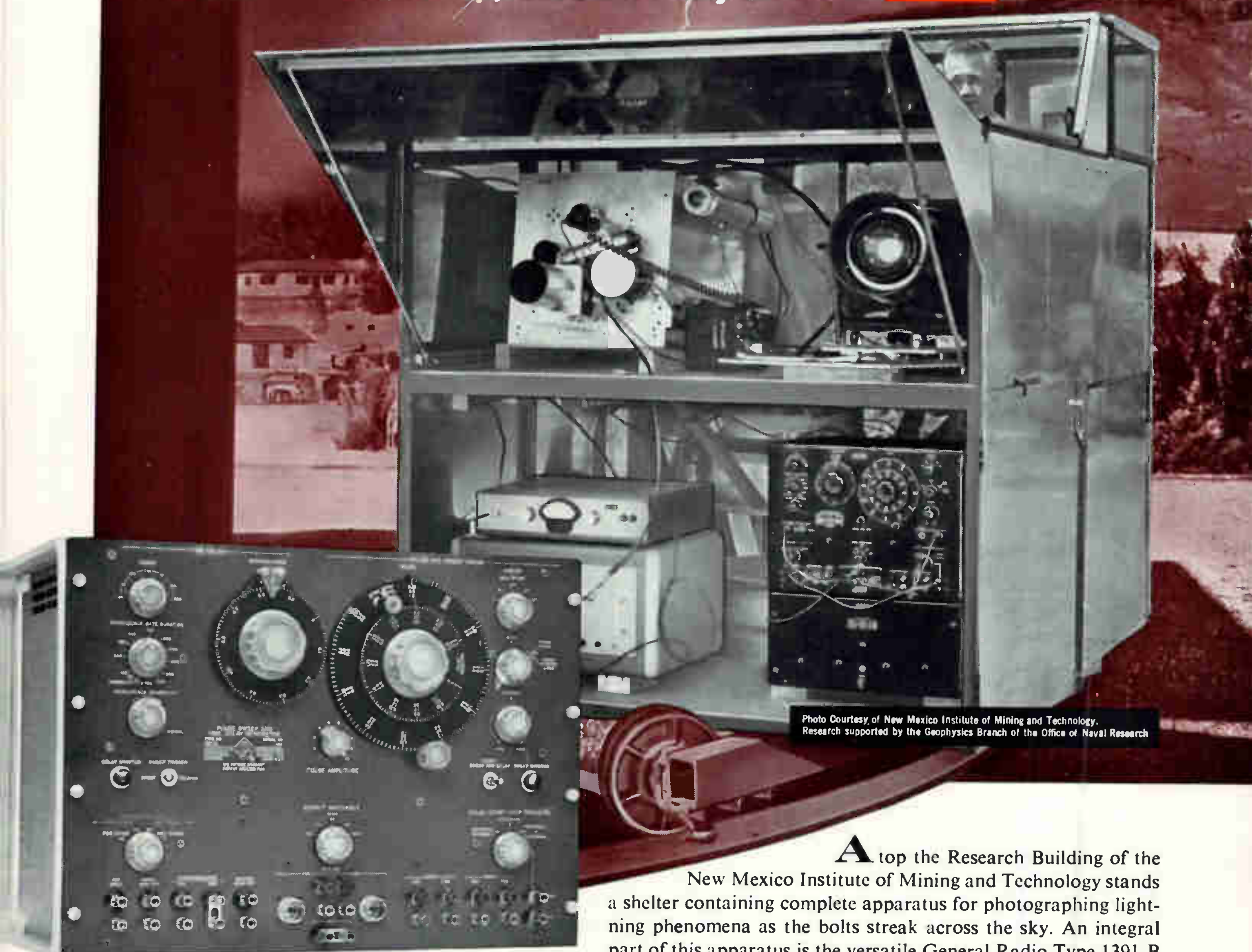


Photo Courtesy of New Mexico Institute of Mining and Technology.
Research supported by the Geophysics Branch of the Office of Naval Research

Type 1391-B
Pulse, Sweep, and Time-Delay Generator

The Complete, Wide Range Pulse Source

- ★ Fast Rise and Decay Times — better than 15 ns.
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- ★ Variable Output Impedance — 50 to 600 ohms.
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PRICE . . . $2025.

Atop the Research Building of the New Mexico Institute of Mining and Technology stands a shelter containing complete apparatus for photographing lightning phenomena as the bolts streak across the sky. An integral part of this apparatus is the versatile General Radio Type 1391-B Pulse, Sweep, and Time-Delay Generator. Increased luminosity caused by the lightning stroke is detected by a photomultiplier tube, which delivers a negative pulse to the Type 1391-B. Using the time-delay function of the Generator, an accurate delay is inserted. This delayed output pulse is then delivered to a Kerr Cell modulator which supplies the necessary 0.1 μsec, 50-kilovolt pulse for triggering the Kerr Cell shutter.

The sweep feature of the Type 1391-B is used to avoid exceeding the duty-ratio restrictions of the modulator. The initial trigger pulse starts the sequence with a pulse to the Kerr Cell, but no new pulses result until the predetermined sweep is over. Disarming the Generator in this manner allows a maximum of one pulse per 3 milliseconds to the Kerr Cell.

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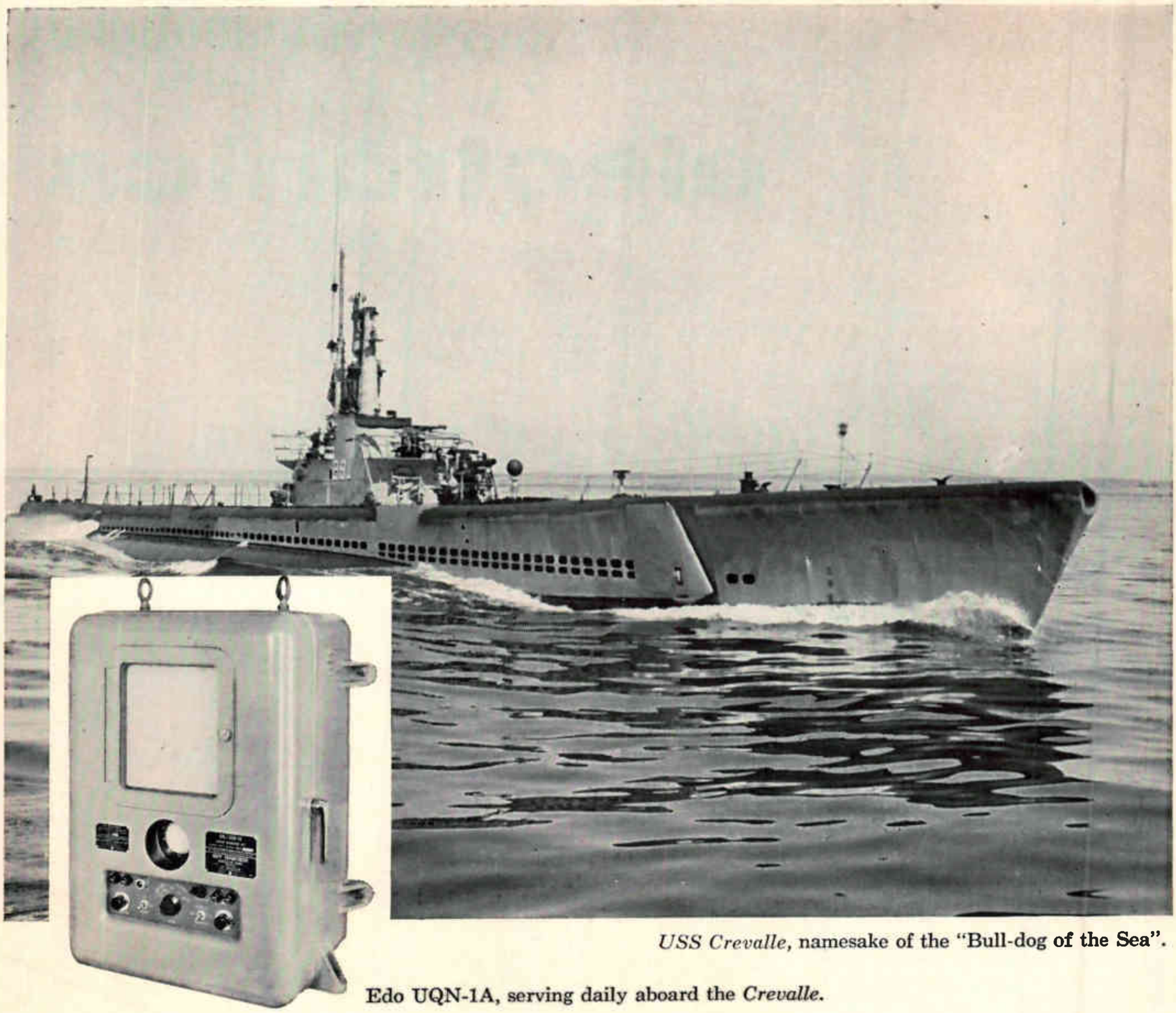
W. W. MacDONALD, Editor



USS Crevalle, namesake of the "Bull-dog of the Sea".

Edo UQN-1A, serving daily aboard the *Crevalle*.

DURABLE DEFENSE TEAM...USS CREVALLE and EDO'S UQN

When the Navy's *USS Crevalle* made her 9,000th dive off New London recently, precise bottom sounding data was relayed to her Control Room crew by Edo UQN-1A, Serial #1. Here's a remarkable record of longevity, in an era noted for fast obsolescence.

The submarine *Crevalle*, commissioned 24 June 1943, made seven war patrols during World War II, sank 22 Japanese ships and damaged 10 more, earned numerous citations for ship and crew. Twice she was decommissioned, twice again re-commissioned. Now, as AGSS 291, the *Crevalle* is in constant operational readiness, also trains new submariners for fleet duty at New London, Connecticut.

Matching the *Crevalle* in durability is the UQN deep depth sounding unit in daily use in her Control Room. Edo delivered this unit to the Navy 20 October 1950. UQN-1A, Serial #1 has since been followed on Edo's production line by more than 1,200 UQN units—a quantity production record unmatched by any comparable equipment.

Edo's UQN, now in a sophisticated 1E model, is standard depth sounding equipment aboard the Navy's surface ships as well as her submarines . . . including the entire new nuclear-powered fleet.

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And now a NEW Arnold service: immediate delivery on your prototype or production requirements for Deltamax 1, 2 and 4-mil Type 6T cores in the proposed EIA standard sizes (see AIEE Publication 430). A revolving stock of approximately 20,000 Deltamax cores in these sizes is ready for you on warehouse shelves. Subject to prior sale, of course, they're available for shipment *the same day your order is received.*

Use Arnold 6T cores in *your* designs. Technical data is available; ask for Bulletin TC-101A and Supplement 2A (dated June '60). ●Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

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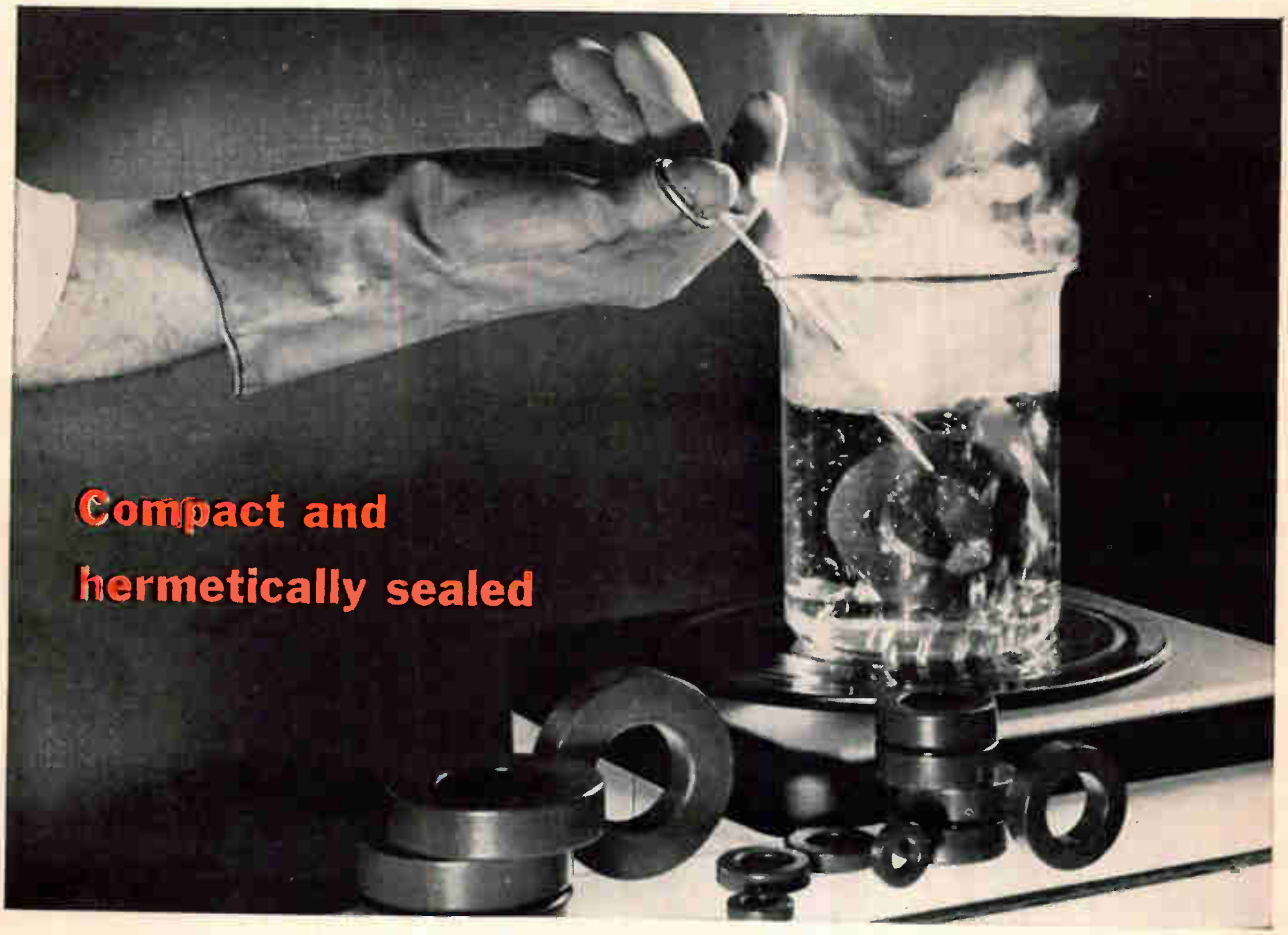

CIRCLE 3 ON READER SERVICE CARD

electronics

November 3, 1961 Volume 34 No. 44

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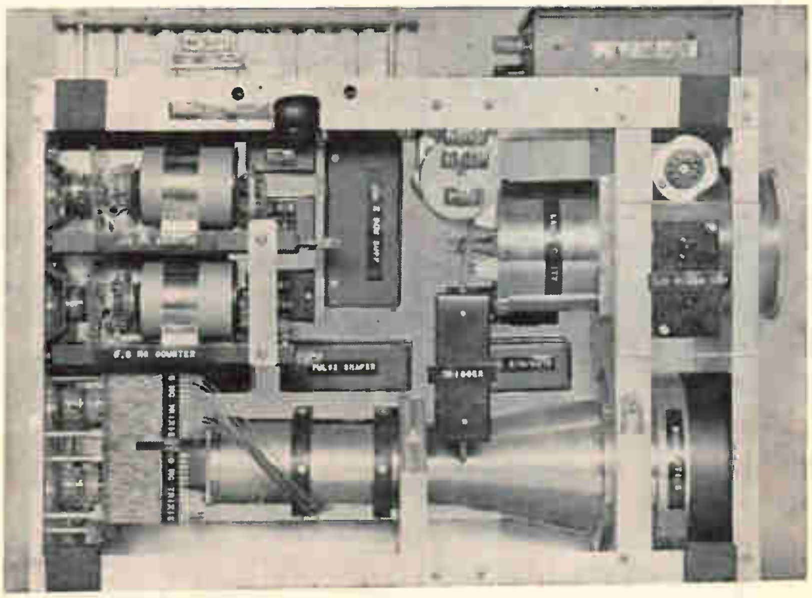
CROSSTALK

LASER RANGING UNIT in a suitcase demonstrates the compact form optical radar may take. With electromagnetic radiation at optical frequencies now a controlled phenomenon through development of the laser, instruments such as this Martin Company unit are considered practical.

Internal view of the self-contained unit reveals: high-voltage power supply (upper right), laser head including flash lamp, ruby and optics (middle right), receiving optics and detector (lower



right), low-voltage power supply (upper center), trigger (center-right), pulse shaper (center-left), batteries (upper left), digital range counters and readout (middle and lower left).

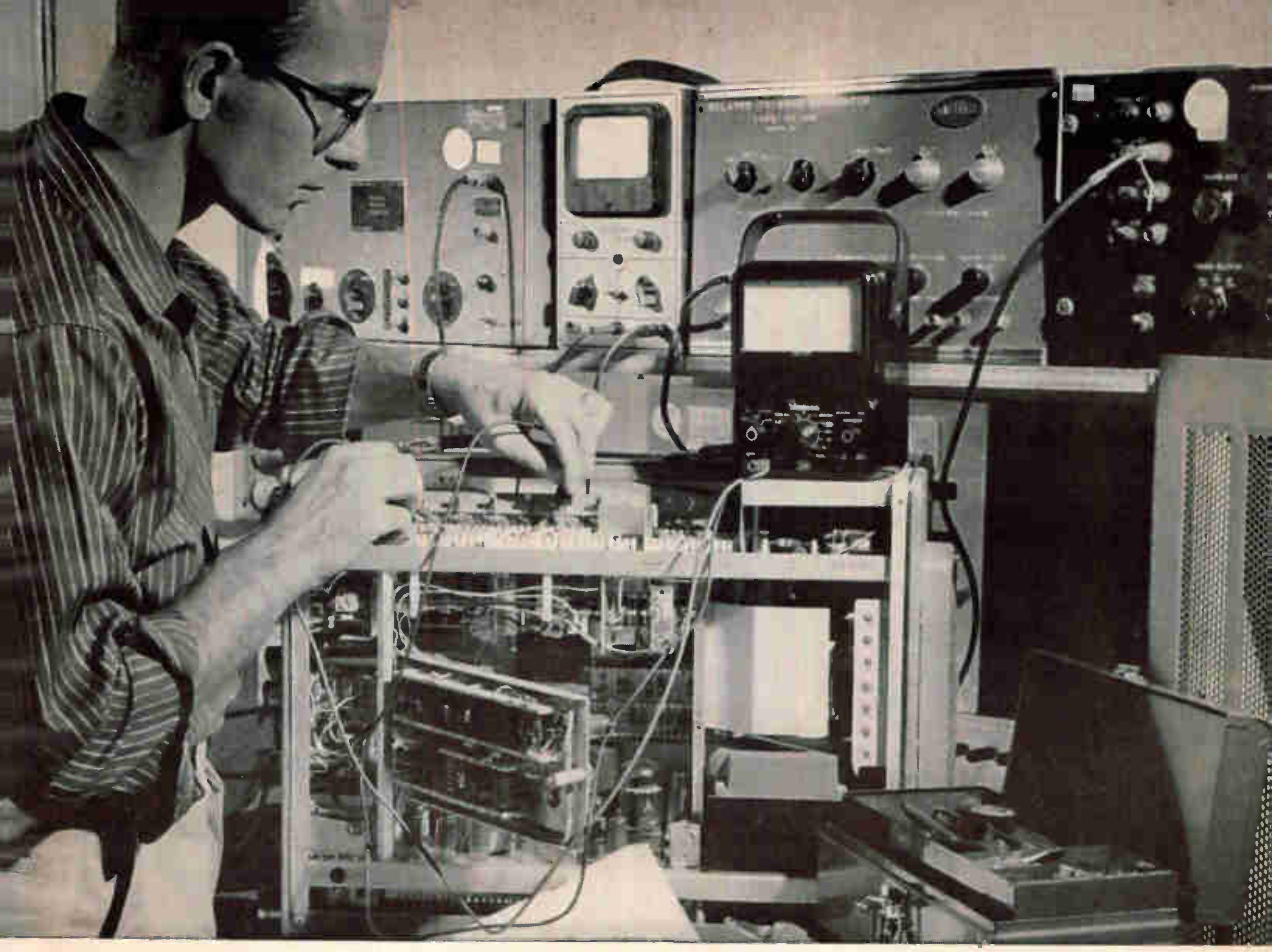
This working prototype will measure range in feet at distances of 3½ to 5 miles; readout is on a digital display. Uses include missile guidance, mapping and surveillance all at high accuracy.

These and other applications of lasers are discussed in the second of a series by Associate Editor Vogel and Assistant Editor Dulberger. Their article begins on p 40.

Coming in Our November 10 Issue

NEREM HIGHLIGHTS. Advances in coherent light, solid-state electronics, radio astronomy and microminiaturization are among developments that will be reported at the Northeast Electronics Research and Engineering Meeting opening in Boston Nov. 14. They'll be spotlighted in next week's conference roundup by New England Editor Maguire.

CIRCLE 5 ON READER SERVICE CARD→



COMMENT

Ions and Health

I have read Warner Clements' comments together with your own which appeared in the September 8 issue (p 6) and which concerned the general subject of ions and health. It has been my experience that everything stated by Mr. Clements can be supported by factual evidence and for the most part has been reported rather thoroughly in the literature, whereas some of the comments in your response are not well documented, at least to my knowledge.

The primary source of ions at the earth's surface is radioactivity of the soil. A second source is from cosmic rays. Other sources at the earth's surface are relatively insignificant and play only a small role in the total ion density. It has been observed that forest fires contribute a major change in the ion density at the earth's surface. Nuclear explosions have also been observed to have a major effect, but these are isolated exceptions. Ultraviolet light has little or no effect at the surface, and it is most frequently observed that the small-ion density is highest in the early morning quiet hours prior to sunrise.

To the best of my knowledge, *both* the positive and negative ion density increase during snow, hail, and to a lesser degree, sleet. The formation of ice crystals has a pronounced effect on the local ion density. The greatest changes in ion density occur during periods of falling barometric pressure, and this is attributed to the exhalation of air from the ground. In higher altitudes the air is cleaner, and therefore the life of the small ion is much greater. This results in a higher small-ion density, and also a higher average ion mobility, because of the lower air density.

It is rather rare that the small negative ions exceed the number of small positive ions at the earth's surface. This has resulted in a good deal of confusion regarding the role of negative ions as a stimulus for good health. Perhaps this can be explained in part by the fact that in our urban centers and inside our homes, local air pollution reduces the small-ion density of both polarities to an abnormally low level, and that most home heating systems generate positive ions only, thereby creating an unfavorable balance. Possibly it is the absence of negative ions that is so detrimental, as a slight excess of positive ions in clean outdoor air is normal.

JOHN C. BECKETT
President
Palo Alto Engineering Company
Palo Alto, California

Patent Practices

It is rather depressing to read the discussions in *Comment* regarding patent practices by U.S. corporations. Mr. Albert Goodman (August 25, p 6) states that "it is standard practice for an employee, upon hire, to sign away all rights . . . whether related to his R&D activities or not." In a collection I made of 20 employee patent agreements used by major companies, all but one of the agreements were restricted to a defined sphere of company activities.

Mr. Goodman refers to R&D paid for by the government. If he were to form his own company, he would shortly discover that he would not be eligible for R&D contracts without a backlog of know-how and experience in the contract field, which would make his own contribution to the work far outweigh the modest profits usually realized.

THOMAS A. TARR
Burbank, California

Silicon-Carbide Varistor

I have received inquiries concerning the type and supplier of the SiC varistors used in the circuit described in my article, Varistor Network Controls Voltage-Tuned Oscillator (July 28, p 44).

All seven SiC varistors I used are of the disk and lead type, 18 mm in diameter and 1.8 mm thick. The supplier is Ishizuka-Denshi Co. Ltd., 2915-2, Koiwa-Cho, Edogawa-Ku, Tokyo, Japan.

MASAMI UNO
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get all the facts about readouts

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-hp- 489A, 1-2 GC

-hp- 491C, 2-4 GC

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Compact, rugged and dependable, these amplifiers incorporate lightweight, periodic-permanent-magnet TWT's; each instrument weighs just over 30 lbs. New ⓗ modular construction combines in a single instrument a portable bench amplifier and a neat, clean rack mount unit.

All four models incorporate specially designed circuitry to provide amplitude modulation from dc to 100 KC, with internal amplification so that small modulation signals cause a large output power change. Very low spurious phase modulation is assured through incorporation of electronic regulation in the helix, anode and filament supplies.

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Model:	489A	491C	493A	495A
Frequency Range:	1-2 GC	2-4 GC	4-8 GC	7.0-12.4 GC
Price:	$2,300.00	$2,300.00	$2,900.00	$2,900.00

Common Specifications

Output for 1 mw Input:	At least 1 watt
Maximum rf Input:	100 mw
Small Signal Gain:	Greater than 30 db
Amplitude Modulation Passband:	DC to 100 KC
Modulation Sensitivity:	Approx. 20 db rf change for a 20 v peak mod. sig. (DC to 50 KC)
Input, Output Impedance:	50 ohms, SWR less than 2.5
Connectors:	Type N, female
Front Panel Controls:	Gain
Meter Monitors:	Anode, helix, collector and cathode current
Dimensions:	16¾" x 5½" x 18⅜" deep (cabinet convertible to rack mount) 19" x 5¼" x 16⅛" deep behind panel (rack mount)
Weight:	31 lbs.

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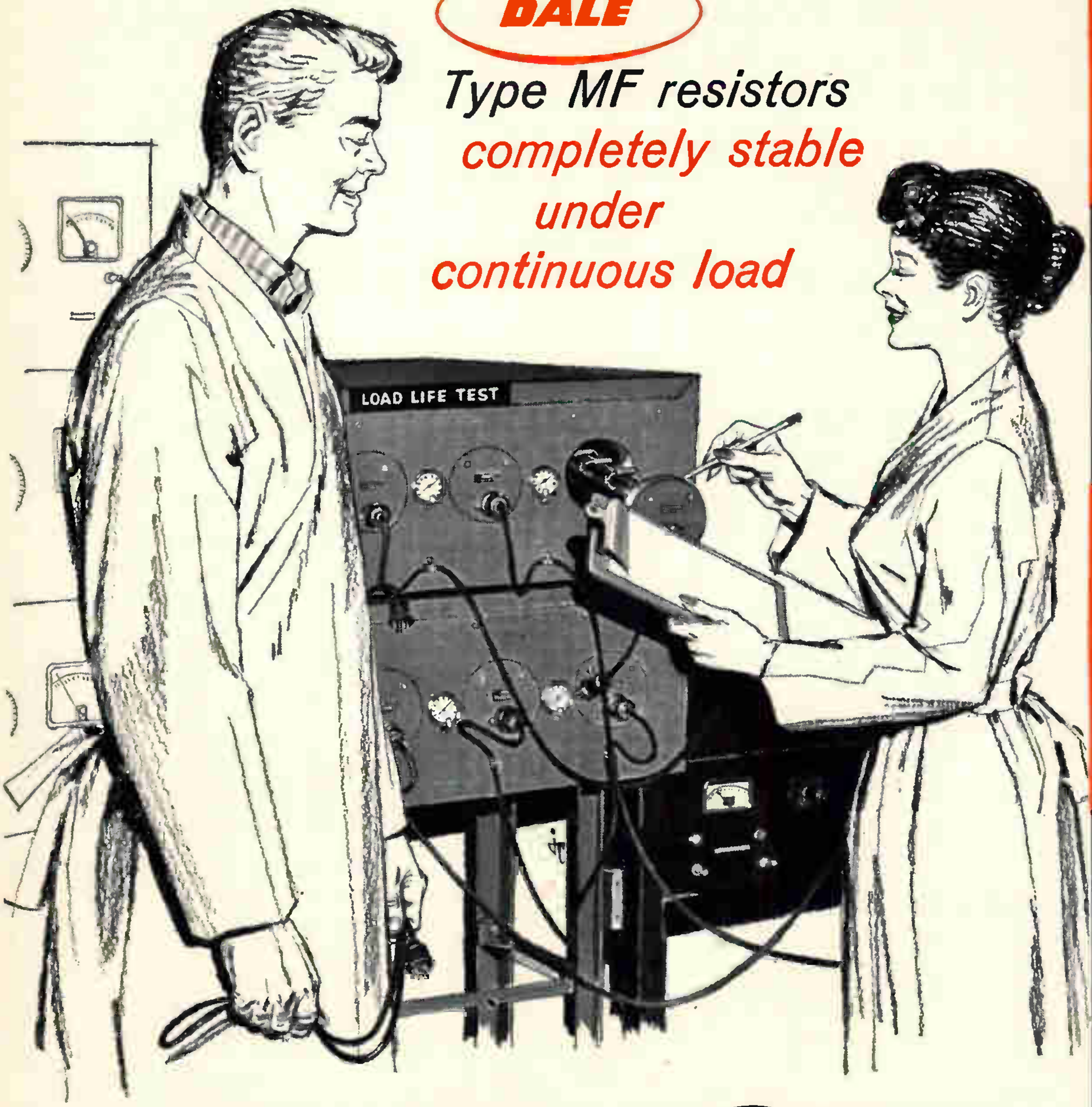

Under any circumstance...placed under continuous load, or held "in reserve" for months...operating under severe environmental conditions of shock, vibration, or humidity . . . Dale precision resistors retain their stability.

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- RATED AT 1/8 watt, 1/4 watt, 1/2 watt, 1 watt, 2 watts
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- COMPLETELY INSULATED; complete protection against moisture and salt spray

Write for Bulletin R 43 and handy cross reference file card

ELECTRONICS NEWSLETTER

Rocket Uses Waves for Launching Pad

PT. MUGU, CALIF.—Feasibility of launching super rocket boosters by floating them in the ocean until firing, then recovering them to drastically cut cost of space shots, is being tested. Last week, Aerojet-General and the Naval Missile Center jointly launched a Seabee rocket four miles at sea.

The Seabee went up 5,000 feet and came down with a parachute. Two months ago, this rocket, tethered by a 30-ft line, was fired from a small lake near Azusa. It is scheduled to go aloft again Nov. 1. Reportedly, this is the first time a liquid-fueled rocket has been launched while floating and the first time the same rocket has been fired twice. Firing signals were received by an antenna on the nose cone, which protruded 4 ft out of the water.

First shot in Navy's Hydra project was a telephone pole with a solid fuel charge at its base. Navy has also fired Arcas rockets equipped with flotation devices.

Raytheon Buys Second Semiconductor Company

RAYTHEON, which bought CBS Electronics' plant recently, is now acquiring a semiconductor plant on the west coast—Rheem Semiconductor, Mountain View, Calif. Rheem's 1961 sales are estimated at over $6 million.

Rheem has specialized in silicon devices for military use. Its forte is mesa types, but it is developing planars and epitaxials, which Raytheon says will fortify Raytheon work in integrated circuits.

Raytheon also announced plans to expand A. C. Cossor, Ltd., of England, which Raytheon acquired in September for $6 million.

Merger of Communications, Data Processing Urged

COMMUNICATIONS system under development at Lincoln Labs, MIT, is aimed at error-free transmission of 8,000 bits a second. System was reported at closing luncheon of Computer Applications Symposium, in Chicago last week, by Prof. Albert Fano. He stressed that the new breed of computer engineers must ignore false boundaries between data processing and communications. New system's improved transmission would more than compensate for added terminal equipment costs, he pointed out.

Inertial Gyros Reduce Missile Guidance Cost

GUIDANCE SYSTEM for short and medium-range missiles uses three inertially driven gyros. Compressed gas starts the gyros spinning, then gas is cut off just before launch. The gyros run for three to five minutes, enough for a 100-mile flight. Lear, which has Army contract to develop the system for a new class of bombardment missiles, claims technique cuts guidance cost as much as ten times.

Tv Interference Wasn't Fault of Needle Belt

GOVERNMENT SCIENTISTS reiterated last week that Project West Ford was not the reason for the rash of complaints here and abroad of interference with tv reception.

They said the reason could be a periodic high reflectivity in the ionosphere's E-layer, or a temperature inversion in the atmosphere, or possibly Russia's nuclear bomb.

Radioactive debris could increase ionization in the ionosphere. Coincidentally, one aim of the orbiting belt of tiny dipoles is to ensure communications in a nuclear war. Thermonuclear blasts at the right altitude would disturb ionospheric scatter communications, but a scattering belt at 2,000 miles altitude would be virtually immune.

Besides, the government scientists said, only highly sensitive instruments could pick up signals from the belt of 8-Gc tuned dipoles. One proof of this was that, up till a few days ago, contact had not yet been made with the belt.

Transistor Manufacturer Sees Profits Rebounding

AT LEAST one semiconductor manufacturer sees "the worst behind us". David Bakalar, president, Transitron claims severe price-cutting has abated and that placement of military prime contracts foreshadows influx of components orders in the next few months.

Bakalar told stockholders last week that company bounced back into black in first quarter ended September 30, after suffering its first net-loss year. Sales were $8.4 million and after-tax net $200,000.

He predicts "plenty of growth areas opening up for semiconductors" and sees "more breathing space" as withdrawals from field and mergers lessen competition. Transitron is looking for acquisitions too, he said.

Tough Road to Hoe? Try This

CZECHOSLOVAKIA says it now has a farming control that is 300 percent more efficient than old-fashioned ways of positioning hoes and other tractor-drawn farm implements.

A vertically moving rod with a roller at the end detects furrow ridges. Signals indicating rod position are amplified in a battery-powered transistor unit. Relays control electrohydraulic valves that adjust the implement bar's position.

New Transceivers Lighten GI's Load

ARMY is replacing its Korean War vintage AN/PRC-8,9,10 with a new model, the AN/PRC-25, which does the same job as the three separate sets and weighs only 17 lb, 11 oz, including batteries.

Developed at Army Signal R&D Lab, Fort Monmouth, it is all-transistor except for a transmitter tube. Thirteen crystals control 920 f-m channels. Selector knobs click for tuning in the dark and stops quickly locate two selected channels.

Army has awarded RCA a $9 million contract to make 8,598 sets.

Air Force Buys Guidance Systems on Incentive Plan

NEW CONTRACT of $17.6 million for Atlas ICBM inertial guidance system has been awarded Arma by Air Force. Purchase is being made under fixed-price incentive contract. Previous contracts were cost plus fixed fee, which provided lower return but reduced risks. System was aboard Atlas on two 9,000-mile flights this year. Arma says it will subcontract $3.8 million in components and materials.

Saturn's Success Paves Way for Moon Shots

"PERFECT" was the word observers used to describe the launching of the huge—bigger and heavier than the Statue of Liberty—Saturn booster rocket last week at Cape Canaveral. If further launches go as well, manned Apollo spacecraft will be in earth orbit by 1964 and in lunar orbit by 1966.

The engines burned 119 seconds, lifting the rocket up 95 miles and out 200 miles—the planned trajectory. The shot was given a 30 percent chance of complete success. NASA officials said they would have been happy with a 60-second flight and content with just the principal objectives, engine ignition and liftoff.

Airborne Scatter System Experiment Is Planned

AMONG THOSE waiting for word on success of Project West Ford was Boeing, which has designed a maneuverable microwave antenna system for installation in its jet tanker-transport, the KC-135.

System is to investigate using the dipole belt for communications with high-flying aircraft. A computer will keep the antenna aimed at the belt while the plane maneuvers.

Other tests will see if aircraft can be used as maneuverable relay points for communication with satellites, space vehicles and other aircraft. Equipment range is 6,000 miles.

Western Union's Birthday Present: $335 Million

WESTERN UNION Telegraph Co. last week announced a $335 million expansion in telecommunications. Projects—to be largely completed by 1964—include a transcontinental microwave system, data communications system for Air Force and two-way, direct-dial teleprinter system.

The announcement was made by Walter P. Marshall, president, at the start of centennial celebrations in Omaha. The Pony Express was put out of business there 100 years ago when crews tied the knot in eastward and westward lines of the first transcontinental telegraph.

Three-Channel Paramp Steps Up Radar Range

THREE-CHANNEL parametric amplifier credited with increasing effective range of an AN/FPS-16 radar by 50 percent has been announced by Varian Associates. It is said to reduce radar system noise figure from 10.5 db to 3.5 db, equivalent to increasing r-f power output by a factor of five.

One amplifier has been sold to White Sands for missile tracking. It employs a new type of gallium-arsenide varactor diode and is pumped by a two-cavity klystron which delivers one watt minimum power at 17.750 Gc. Frequency range is 5.42 to 5.85 Gc tunable, and instantaneous bandwidth is 25 Mc minimum.

In Brief . . .

CONTINENTAL Electronics Mfg. Co., which built Navy's $50 million vlf station at Cutler, Me., has contract to design similar station in Australia.

CANADIAN Army has mobile radar set that can find enemy battery by backtracking flight of incoming shell or rocket.

UNIVAC reports it has 166,000 binary digit thin-film memory with nondestructive readout, occupying one-third cu ft.

NASA CONTRACT awards include $19 million to Douglas Aircraft for Delta vehicles and $8.6 million to Ling-Temco-Vought for Scouts.

ARMY is buying $8.3 million in classified equipment from Sperry Rand; $2 million in radar for Hawk missiles from Raytheon; $3 million in Motorola surveillance gear.

NAVY contracts include $6.5 million to Sperry Gyroscope for passive submarine detection systems; $2 million to Hazeltine for radar range-height indicators; $1 million to GE for Sidewinder missile guidance control.

AIR FORCE production orders include $2 million to Motorola for teleprinters; $1.9 million to Kollsman for automatic astro compasses; $1.2 million to Dubrow Electronics for radar.

LINK won $3 million in Navy and Air Force contracts for trainers, simulators and service; Motec Industries, $1.4 million for various components; Collins Radio, $1.8 million for airborne communications and navigation equipment and test sets.

GE IS INSTALLING communications systems at Titan II missile bases at Davis-Monthan, Little Rock and McConnell Air Force Bases.

RCA SUBCONTRACTORS for Air Force Satellite Inspector program (formerly Saint) include Minneapolis Honeywell, guidance; Westinghouse and Emerson Electric, radar.

FAA WILL BUY another $1 million in dopper direction finders from Servo Corp. of America, for total of $2.7 million.

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When it comes to High Voltage power packages—boosting power or shrinking size or both together—AMP's Capitron Division is completely equipped to tackle your toughest design and production problem. It has skilled personnel and research facilities—has the exclusive AMPLI-FILM dielectric for tremendous power in smaller packages—has, too, extensive production facilities to give you High Volume and complete quality control.

And, for off-the-shelf power packages, Capitron has developed keep-alive, indicator and modulator power supply packages that set new standards for high output and small cube. Whether your requirement concerns low ripple voltage, close regulation, minimum size or rugged construction, see Capitron first. Engineering facilities are also available for designing AC/DC input transistorized supplies for missile or other applications. For more information, write today.

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CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

FASTER TAX WRITE-OFFS for production equipment in the electronics industry can be expected when the Treasury Department revises Bulletin F, the guide for Internal Revenue agents. Indication of what is in store for other industries is contained in a ruling given the textile industry for special reasons. Textile equipment that had a tax life of 25-40 years is now written off in 15 years; tax life of other equipment has been cut from 12-20 years to 12.

Growth industries, like electronics, are expected to benefit most from Treasury rulings next spring. Rate of technological advance and machinery obsolescence will be the criteria for faster write-offs. This, plus the development of better machinery under pressure of domestic and foreign competition, was the basis for the ruling on textile equipment. Electronics industry will have to show government officials that present depreciation rates are out of line with industry practice.

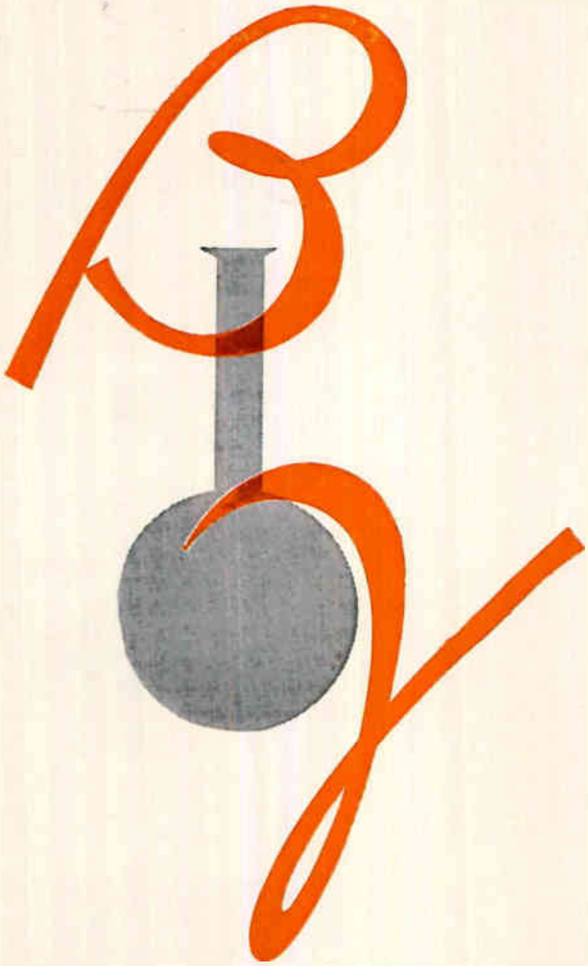
FEDERAL AVIATION AGENCY proposes that all non-airline, turbine-powered aircraft weighing over 12,500 lbs and all planes in this weight class certificated to fly above 25,000 ft be required to have electronic flight recorders on board. FAA requires flight records because of their importance in accident investigations. All turbine-powered airline planes and all airline aircraft certificated to fly above 25,000 ft now are required to carry this equipment. Before the proposal is put into law, the agency is surveying the aviation industry for its views.

LATEST COMMERCE DEPT. figures show that shipments of selected electronic components rose three percent in April-June, 1961, over the previous quarter. Military shipments rose about two percent, nonmilitary about four percent. Second quarter 1961 output was about three percent over production in the same period last year. Nonmilitary shipments were up about six percent from last year and military down about one percent.

DEFENSE DEPT. is embarking on a policy to bolster the status of its major R&D installations. Laboratories will be given a more direct monitoring authority over R&D projects, pay scales for engineers and scientists on military payrolls will be boosted, and management of laboratories will be streamlined to limit authority of nonscientific administrators.

Defense officials say there is no intent to reduce R&D contracting. The outlook is for continuation of the present defense R&D trend: roughly 25 percent in-house, five percent by private non-profit research organizations, the remaining 70 percent by industrial contractors.

TREASURY SECRETARY Douglas Dillon said last week that electronic processing of tax returns will be introduced gradually, starting in the Southeast next year. Internal Revenue Service paperwork has been mounting: total tax returns will go from 94 million to 111 million by 1970. Edp will allow thorough cross-checking instead of sampling.



β *beta rays*

γ *gamma rays*

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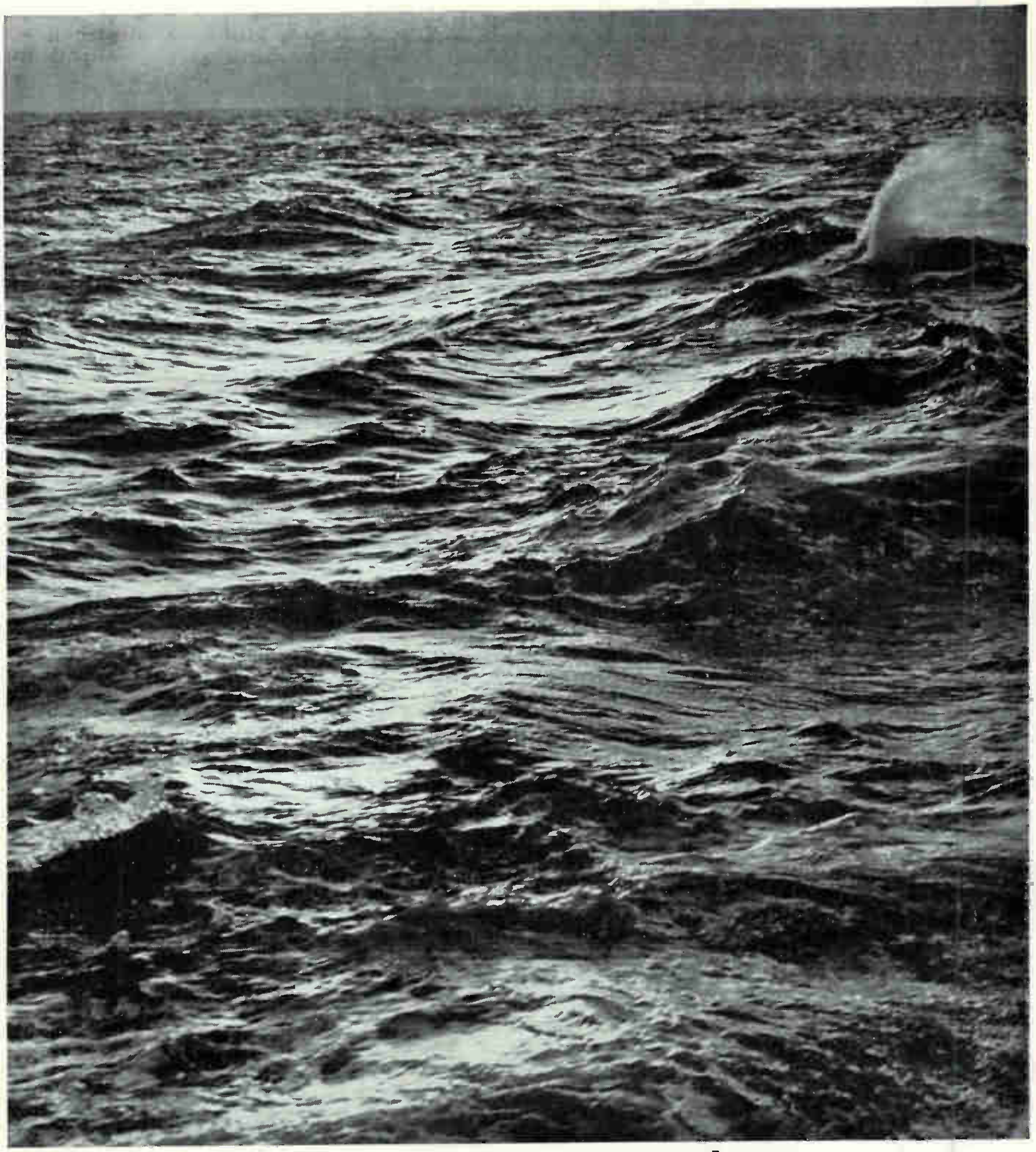
CIRCLE 15 ON READER SERVICE CARD



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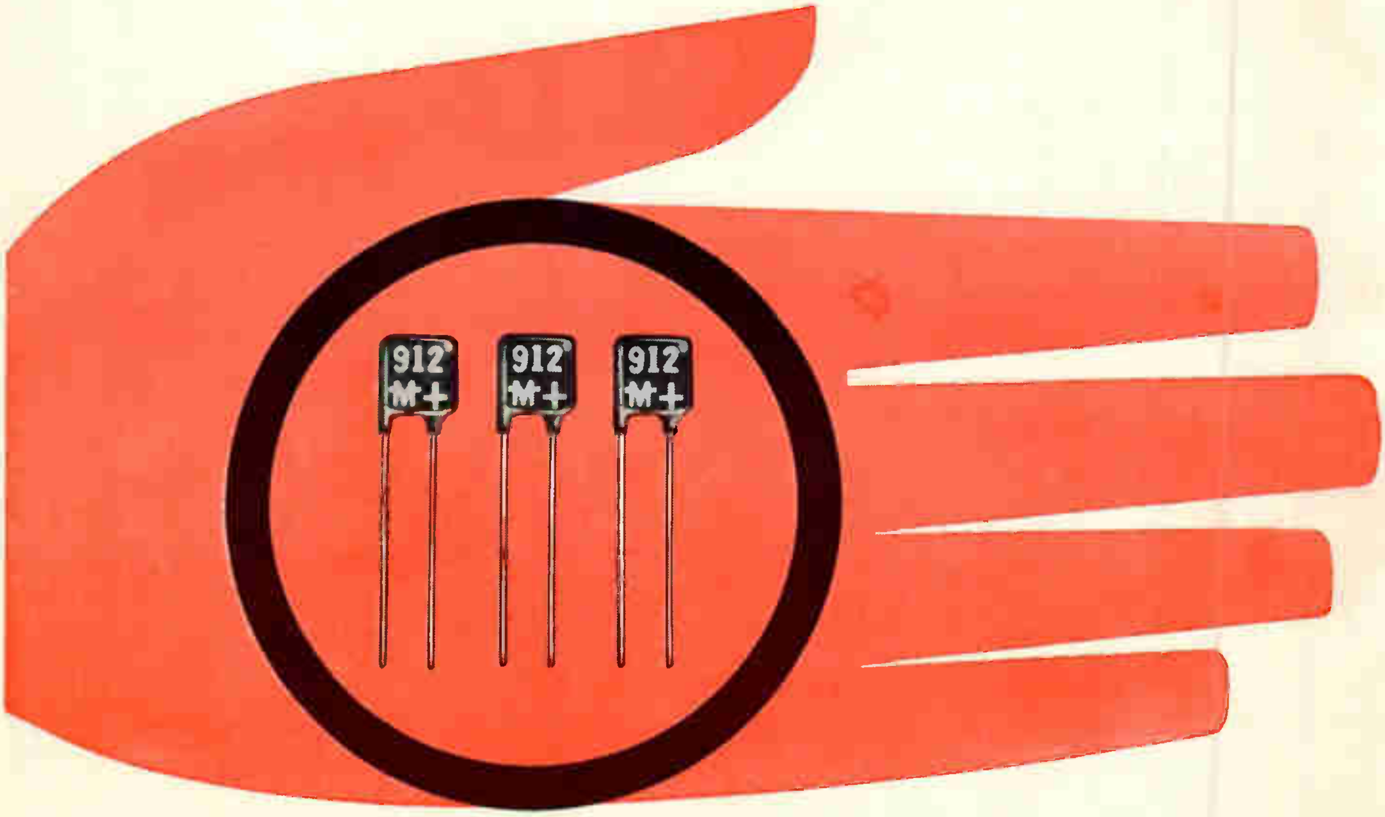

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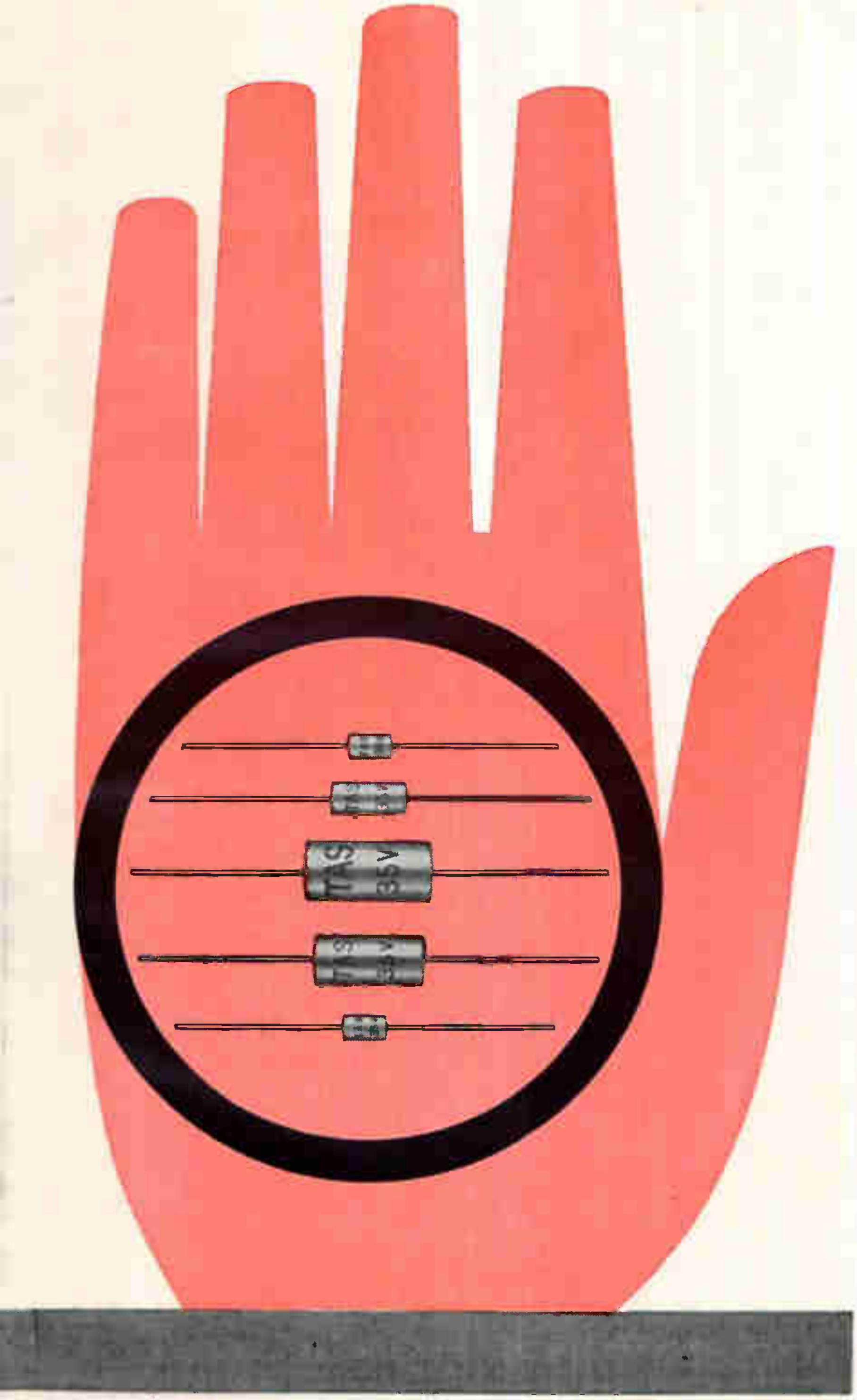

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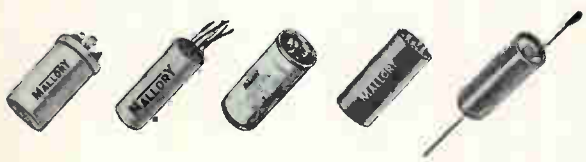

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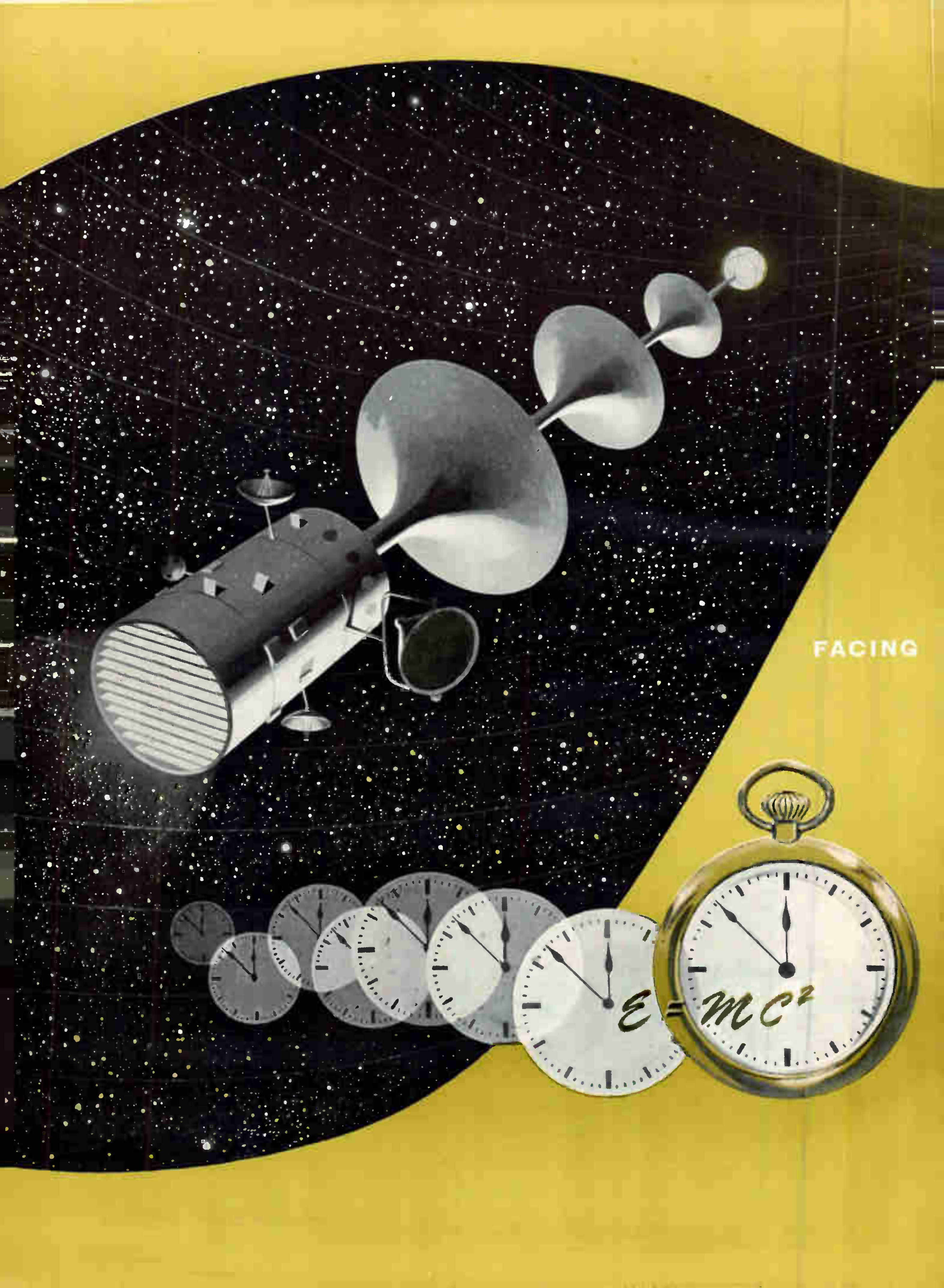
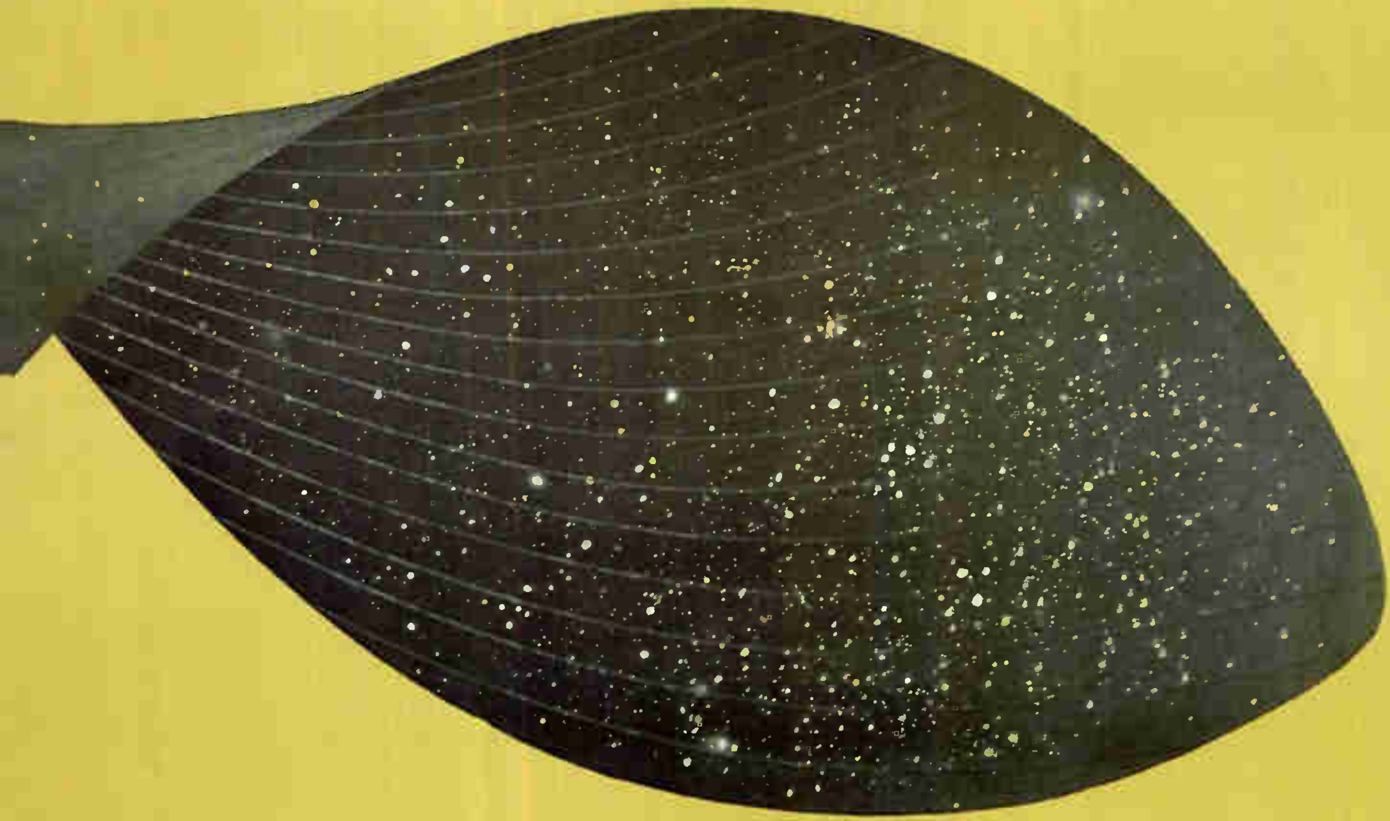
CIRCLE 21 ON READER SERVICE CARD


FACING
E = MC²



THE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles & Space Company, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles & Space Company in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24C, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required. An Equal Opportunity Employer.

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I. C. Liggett, flanked by B. W. Pollard and J. W. Barker, makes a point during symposium in Houston

Standard

American Standards Association committee will soon submit codes and standards aimed at allowing computers to talk to computers

By GLENN GREEN
McGraw-Hill World News

HOUSTON—Next generation of computer systems will probably use a new standard code to facilitate communication between systems of different manufacture without laborious, expensive translation.

This was the consensus of formal and informal discussions during the recent National Conference on Standards of the American Standards Association.

The new standard code will allow manufacturers to implement codes internally in data processing equipment with no rise in manufacturing costs, or even a reduction in some cases.

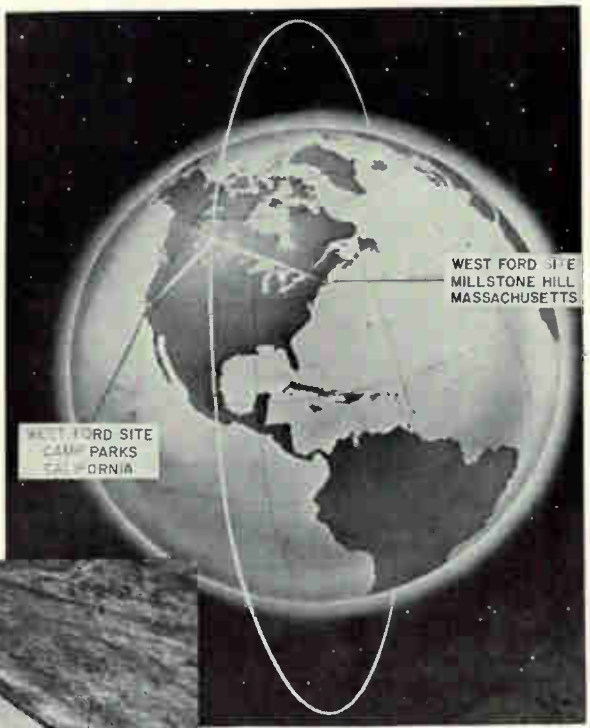
In a next few weeks, a single, seven-bit, dense binary code, with subsets and a superset to meet the varied demands of data processing, will be submitted to the industry and other interested parties for comment. This code is expected to facilitate communication between data processing systems.

Youth of the data processing industry is a basic reason why standardization hasn't been obtained earlier, the group noted. As the industry expanded rapidly, each manufacturer pursued an independent line of development. Now the search is for a common basis which will still allow each manufacturer to develop his own hardware. But end products will be able to communicate with the end products of other systems.

It is felt that magnetic tape probably will be the most commonly used medium. However, none of the group was willing to write off any other known medium nor to discount some entirely new medium being discovered. Therefore, the standardization proposed will not "freeze prematurely" development of more advanced hardware for its implementation.

The first quarter of 1962 will see a firmed-up recommendation for a numeric font resulting from the ASA's optical character recogni-

Needle Belt to Circle the Earth



Air Force artist's conception shows how bundle of fine wire dipoles will orbit the earth for Project West Ford orbital scatter communications experiment. Needles were launched two weeks ago, but ring around the earth is not expected to be fully formed for another few weeks. Although launch was apparently successful, radar had not located dipole cloud last week

Terminal equipment of project at western base, Camp Parks, Calif.

Computer Code Almost Ready

tion work. Two font sizes suggested are 0.056 × 0.094 and 0.056 × 0.140. However, one font, 0.056 × 0.112 may be the compromise size. All character shapes will be based on a 9 × 5 grid.

Tolerance specifications and a set of format rules are being evolved to permit document intermixing with a minimum of adjustments. Development of an alphanumeric font will follow a numeric font recommendation. Since an alphanumeric font will require differentiation among at least 36 different shapes, as compared with 14 for the numeric font, it is possible that two separate fonts may evolve.

"On a philosophical basis," the group felt "there is no reason why it would not be possible eventually to machine read a person's handwriting."

These developments aren't expected to cause any early abandonment of punched-card systems. It would require considerable time to change from the estimated $1¼ billion worth of data processing equipment installed currently in the U. S.

A language programming survey has been completed of the compiler type languages in use today in the U. S., resulting in a greatly-accelerated program to evaluate Algol (universal algorithmic or algebraic language) and Cobol (English-like common business oriented language). A glossary of programming language terminology also is being prepared. The evaluation results are expected to be complete by about June, 1962.

The outline of the status of standardization work in the data processing field was presented by Joseph W. Barker, engineering director of Business Equipment Manufacturers Institute and chairman of ASA's sectional committee X3 (on data processing standards), and these members of various X3 subcommittees: Brian W. Pollard, Burroughs Corp.; I. C. Liggett, Computers Usage Co.; Mrs. Jessica Melton, Center for Documentation and Communications Research; and R. E. Utman, Remington Rand.

Barker emphasized that the group has concentrated on standardizing "the software" in its initial studies. "We want to go slow on the hardware."

Extend Transistor Frequency

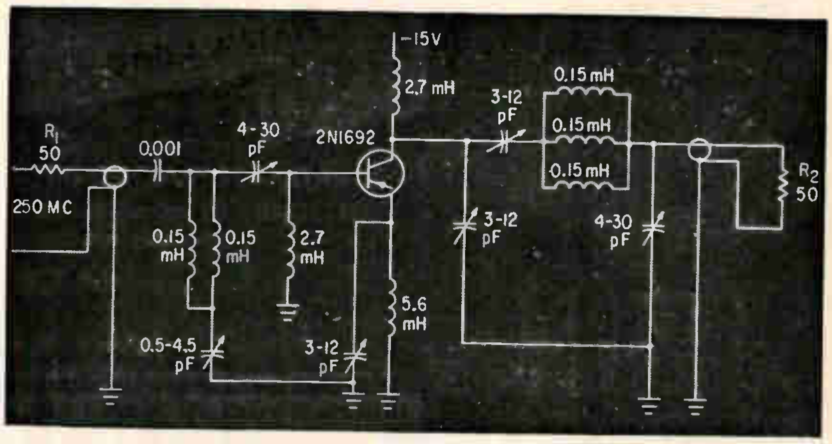
USEFUL FREQUENCY range of transistors and high-frequency amplification capabilities of vhf and uhf units are reported to be increased by a circuit developed at Motorola Semiconductor Products.

Motorola says the new operating mode has increased h-f gain more than 20 db in some cases, reduces interstage matching problems, improves selectivity and stability and reduces circuit costs. The technique works best above 100 Mc and is considered essential in the gigacycle range. It was invented by W. A. Rheinfelder.

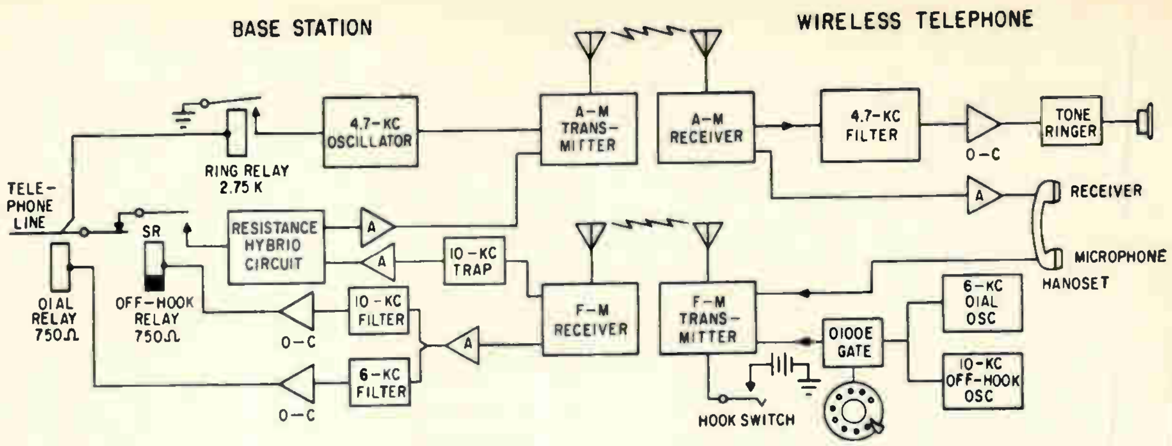
The configuration neutralizes inductances in the emitter circuit, a limiting factor in h-f performance. These inductances reduce the transistor's transconductance and input resistance, causing losses of 6 db to 20 db at frequencies as low as 100 Mc, according to Leo L. Lehner, manager of applications engineering.

Neutralization is achieved by a small variable capacitor from emitter to ground and an r-f choke which provides a d-c path. This avoids losses in the emitter tuned circuit.

Circuit adjustments are made by adjusting the variable capacitor to the operating frequency. This is independent of the specific transistor, so long as the intrinsic cutoff frequency of the transistor junction is high, Lehner said. If cutoff frequency is limited by the junction, as in low-frequency power transistors, no improvement can be obtained.



Test circuit, a 250-Mc transmitter, demonstrates a typical application for the new circuit configuration



Base station picks up telephone line when caller lifts handset and dials. When an incoming call is received, transmitter goes on and an electronic tone ringer sounds

RINGING RADIO IS

WIRELESS TELEPHONE

EXPERIMENTAL TELEPHONE, free of any cord leading to telephone lines, has been developed by Automatic Electric Laboratories, Northlake, Illinois. While the wireless extension telephone is technically and economically feasible, the company says, the shortage of FCC frequency allocations will indefinitely delay marketing of the phone.

The phone looks like a standard dial phone. But it is completely portable and can be used as an extension phone anywhere within range of its "base station," about 150 feet. It is operated the same as any dial telephone and handles incoming and outgoing calls.

In its present state of development, the wireless extension phone could find many uses beyond that of the normal extension phone. In the home, it could be carried to any room, or to the basement, garage, patio, or pool.

Business and industry applications foreseen include use in hotel lobbies, lumber yards and airline terminals. It could also be used in restaurants, conventions, factories, hospitals, schools and prisons.

The telephone is made up of two basic units, the deskset phone and its base station. Built into the phone's base is a miniature low power f-m radio transmitter and a miniature a-m receiver. The receiver-transmitter is powered by mercury cells. The base station consists of an f-m receiver and an a-m transmitter powered by 115 volt commercial line voltage. The output of the base station is fed into a telephone line.

When the handset on the wireless telephone is lifted, the hookswitch makes contact (see block diagram) and energizes the f-m radio transmitter. The f-m transmitter is modulated by a 10-Kc tone that indicates the handset is offhook.

When the f-m receiver in the base station receives the 10-Kc signal, it is fed through the 10-Kc filter to a d-c amplifier which operates the offhook relay, seizing the telephone line and energizing the a-m transmitter.

These two men could be telephoning from different cities

Dialing impulses pass through the diode gate which cuts out the 10-Kc offhook tone and cuts in the 6-Kc tone. This converts dial pulses to tone pulses which are transmitted to the base station.

The 6-Kc dial pulses are received by the f-m receiver in the base station and fed to a d-c amplifier through the 6-Kc filter. A train of 6-Kc tone pulses causes the d-c amplifier to pulse the dial relay, repeating the dial pulses to the telephone line.

When the called person answers his phone, the wireless telephone and base station are prepared for the audio portion of the cycle. Audio from the f-m receiver in the base station is fed through a 10-Kc trap that keeps the off-hook tone from the audio circuits. The audio is amplified and fed to the resistance hybrid circuit, and then to the telephone line.

The resistance hybrid circuit, common in telephone circuitry, reduces disturbing audio transmission from microphone to receiver in the handset.

When the number of the wireless telephone is dialed at any fixed station, ringing current actuates the ring relay in the base station, which turns on the a-m transmitter. The a-m transmitter is modulated with a 4.7-Kc tone. This signal, picked up by the telephone's a-m receiver, is fed to the 4.7-Kc filter coupled to a d-c amplifier which controls the electronic tone ringer. Whenever an r-f signal modulated by 4.7-Kc enters the receiver, the electronic tone, or "bell", rings.

When the called party lifts the handset, the hookswitch makes contact and activates the f-m transmitter. The f-m receiver in the base station picks up the 10-Kc signal from the transmitter and off-hook relay is activated, completing the audio circuit.

An electronic tone ringer is needed because the standard electromagnetic ringer operates on voltages too high for the battery-powered phone and would use space needed for electronic components.

This "ringer" posed a difficult design problem. To receive a ringing signal at any time, the a-m receiver in the telephone must operate 24 hours a day. Current drain must be minimized to increase battery life. The a-m receiver in Automatic Electric's experimental model was designed for a power consumption of less than one milliwatt.

King-Size Satellite

Grumman Aircraft Engineering Corp. personnel are dwarfed by design model of Orbiting Astronomical Observatory (OAO) being built by the company for NASA. OAO is 9.5 feet high. Men are comparing model with tiny Vanguard I, smallest U.S. satellite

Midas Will Use New Display

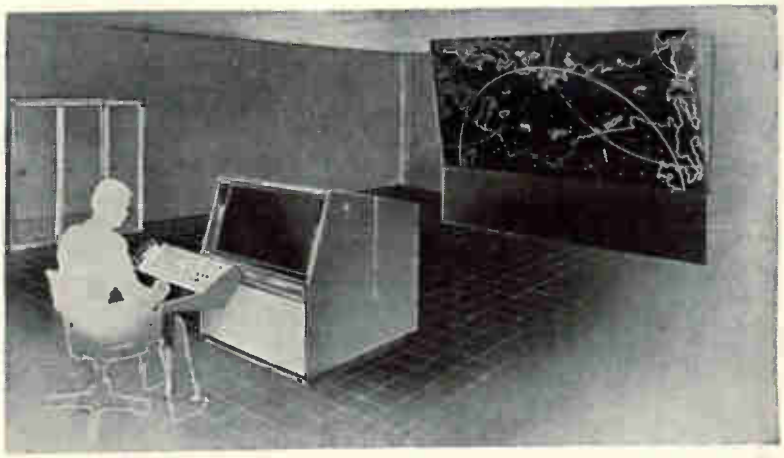
MILITARY COMMANDERS will be able to analyze the infrared sensed data flashed back to earth by orbiting Midas satellites on a new display system that offers real-time data in multicolor, on large screens, in normally lighted rooms.

The system, called Melva (Military Electronic Light Valve) is being developed by General Electric's Heavy Military Electronics Dept. for Lockheed Missiles and Space, Air Force's Midas contractor.

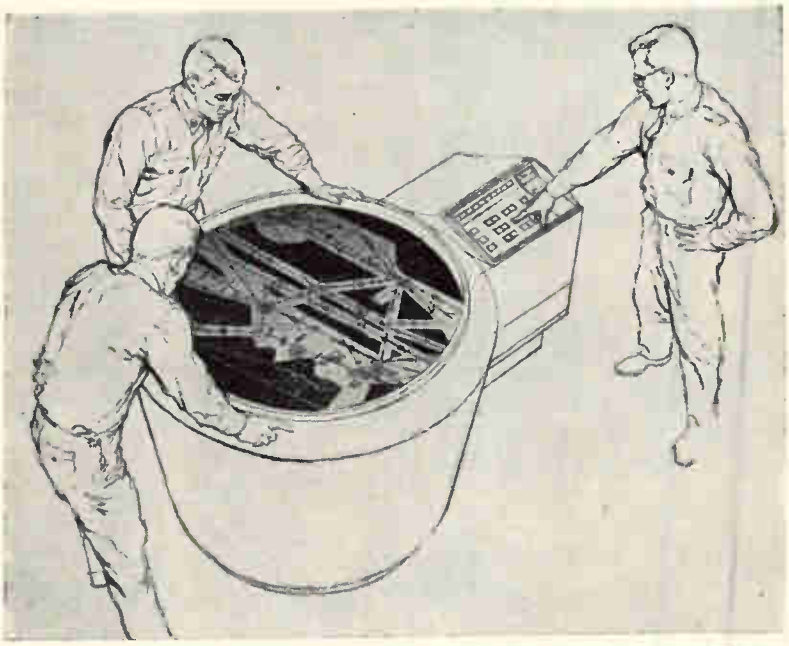
The situation display console consists of a basic display, a projection screen and system controls. Data from the satellite can be displayed on a tv-size console for use by an individual operator, or projected on a six-by-nine-ft screen for command analysis. Push button controls on the display console will permit the battle commander to view individual sectors for more detailed information. Data from multiple satellites will be displayed in various colors for rapid identification.

The amount of data that can be displayed is limited only by the viewers' ability to assimilate it, GE says. A variety of lines as well as several different geometric symbols can be displayed. Up to 2,000 symbols can be displayed at once.

Tags are generated electroni-



Readout from Midas satellite (Missile Defense Alarm System) will be on operator's tv-like panel or projected on big screen



Horizontal display can be used for air traffic control. Aircraft in various colors to show altitude move along map-like airlanes cally rather than by voice command. The situation is displayed on the related geographical background, projected on the screen from a slide automatically selected from storage. Both target data and background are presented in color.

The most common electrical-to-optical transducer is the cathode-ray tube. To project the image several techniques are used. One method is the Schmidt optical system. Insufficient light has been a serious deficiency of this system because of the inherently low efficiency of the direct conversion of electrical energy to light, GE says.

Projection Techniques

For large, bright displays several intermediate film or paper processes have been used. This system requires time for processing before projection is possible.

GE claims to combine the best features of each system in Melva. The Melva projection technique involves placing a transparent control layer in the light path of a projection system. Electrical charges are deposited on this control layer by an electron beam. Electrostatic forces cause a deformation of the control layer wherever charges are deposited. Light passing through the undeformed areas of the layer is optically converged and intercepted by an opaque stop or disc. However, light passing through the deformed or "written-on" areas is refracted around the opaque stop and reaches the projection lens so that each deformed element of the control layer is focused on its corresponding element on the projection screen.

Other Applications

Melva has a number of applications. Besides Midas, it is also being used in the 412-L "Little Sage" Tactical Aircraft Control and Warning System being built for Europe, the Pacific and the U. S.

According to GE it can also be used for air traffic control, communication satellite systems (showing the position of all satellites in the system as well as the line-of-sight areas of ground coverage at any given moment) and space surveillance (showing friendly, enemy, unidentified satellites). Using a three-dimensional form, it may be used for global surveillance.

Computer Evaluates Students

CHICAGO—Automated classrooms, improved methods of medical diagnosis, library automation, ways to boost factory production were among topics discussed last week at the two-day Computer Applications Symposium sponsored by Armour Research Foundation.

Class (Computer-based Laboratory for Automated School Systems) was described by Donald Englund, System Development Corp. It can instruct 20 students simultaneously.

Digital readout from a real time instruction control program directs the student to a frame in his film viewer. Respondng, he presses answer keys. The response is evaluated and the computer, a Philco 2000, activates feedback lights.

Teacher monitoring facilities are provided at the console. A student alarm lights up when an individual's error rate or response time indicates trouble. Additional programs prepare and process data for school administrators and counselors.

Medical Diagnosis

Robert S. Ledly, National Biomedical Research Foundation, reported a sequential decision method of optimizing medical diagnosis and treatment. The diagnostic process is converted to mathematical models and programmed into a computer. The computer compares diagnostic possibilities with a complex list of all illnesses.

If physicians are to learn to communicate with the computer and evaluate its information correctly, Ledly said, standard nomenclature, coding procedures and test interpretations will be needed.

Louis A. Schultheiss, University of Illinois, discussed a library automation system under joint development with GE. Goal is generation of control records for annual processing of 40,000 volumes, 650,000 serial pieces, 17,000 new catalog cards and 70,000 revised cards. Since information rerieval is not the object, batched work can be handled by computer during nonprime times.

David Scheraga, of General Electric, said assembly line efficiencies can be boosted to 90 to 98 percent when sufficiently flexible data is presented to a computer. Poor line balancing, he estimates, wastes four to 12 percent of assembly labor in industry. With a computer, a typical line can be balanced in five minutes instead of more than four hours, he reported.

LOGIC NEXT ESPERANTO?

"INTELLECTRONIC" *man-machine partnership of the future will develop a new kind of world-wide, logical language, Simon Ramo, of Thompson Ramo Woolridge, told 300 engineers and scientists attending the ARF computer symposium's opening luncheon.*

Just as binary and octal numbers have been replacing the decimal system in computers, the new intellectronic language, following precise rules, will promote standardization better than Esperanto, he suggested. Color codes, sound patterns and other signals may possibly be assigned standardized communication significance.

Electronic machines will become highly intellectual, he said, fostering revisions in government, banking, law and medicine. Man will concentrate on creation of new and improved systems, and on big issues. Supplied by machines with properly processed facts, the world of the future will be more reliable, Ramo expects.

Intellectual electronics is forcing man to become more scientific, logical and consistent in his approach to every intellectual task, he noted.

Company Starts Producing Medium-Scale Computer

MINNEAPOLIS-HONEYWELL reports it has started mass production of its new Honeywell 400 medium-scale computer. First unit was put into use last month. Announced speed is 10,000 three-address operations per second. Its central processor can handle some 200,000 decimal digits a second.

MEETINGS AHEAD

HIGH MAGNETIC FIELDS, International Conf., Air Force Office of Scientific Research; MIT, Cambridge, Mass., Nov. 1-4.

INSTRUMENTATION Conf., Louisiana Polytechnic Institute, Campus, Ruston, Louisiana, Nov. 2-3.

MAGNETICS, Non Linear, AIEE, IRE; Statler-Hilton Hotel, Los Angeles, Nov. 6-8.

DOCUMENTATION, American Documentation Inst. Annual Advanced Retrieval Theory; Kresge Auditorium, MIT, and Hotel Somerset, Boston, Nov. 6-8.

RADIO INTERFERENCE Reduction and Electronic Compatibility; IRE, Armour Research Foundation; Illinois Inst. of Technology, Chicago, Nov. 7-9.

COMPUTERS, Transistorized, Effective Use of Marginal Checking, PGRQC of IRE, PGEC of IRE; Burroughs Corp., 215 Park Ave. S., N.Y.C., Nov. 13.

EXPLODED WIRE Phenomena, Electrical, Air Force Cambridge Research Laboratories, Hotel Kenmore, Boston, Nov. 13-14.

MAGNETISM & Magnetic Materials, IRE, AIEE, AIP, ONR, AIME; Westward Ho Hotel, Phoenix, Arizona, Nov. 13-16.

MATERIALS and Design Exhibition Conf., Earls Court, London, Nov. 13-18.

RELIABILITY Symposium, Electronic Systems, IRE, Linda Hall, Library Auditorium, 5109 Cherry, Kansas City, Mo., Nov. 14.

ELECTRONICS Conf., Mid-American, MAECON; Kansas City, Mo., Nov. 14-16.

NEREM, Northeast Research & Engineering Meeting, Commonwealth Armory and Somerset Hotel, Boston, Nov. 14-16.

AEROSPACE Electrical Society, Pan Pacific, Auditorium, Los Angeles, Nov. 15-17.

ELECTRICAL MANUFACTURERS, National Assoc., Annual, Plaza Hotel, N.Y.C., Nov. 16.

VEHICULAR Communications, PGVC of IRE; Madison Hotel, Minneapolis, Minn., Nov. 30-Dec. 1.

COMPUTER Conference, Eastern Joint, PGEC of IRE, AIEE, ACM; Sheraton-Park Hotel, Wash., D.C., Dec. 12-14.

RELIABILITY AND QUALITY CONTROL, PGRQC of IRE, AIEE, ASQC, EIA; Statler Hilton Hotel, Washington, D. C., Jan. 9-11, 1962.

MILITARY ELECTRONICS, PGMIL of IRE; Ambassador Hotel, Los Angeles, Calif., Feb. 7-9, 1962.

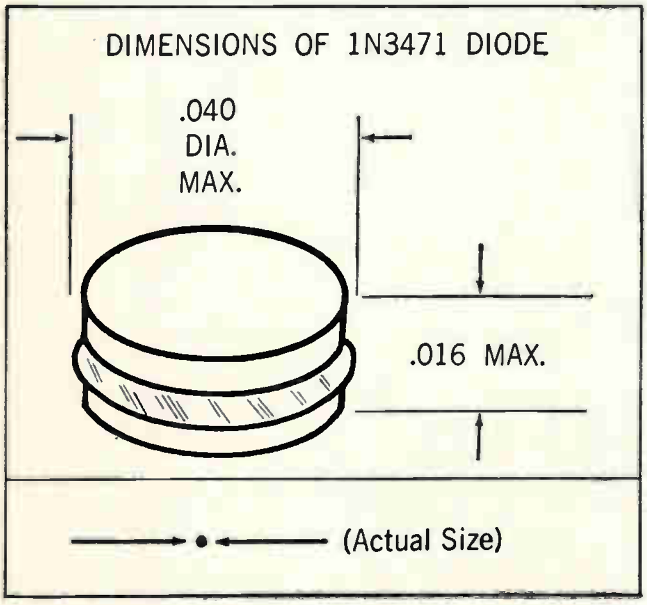
IRE International Convention, Coliseum & Waldorf Astoria Hotel, New York City, Mar. 26-29, 1962.

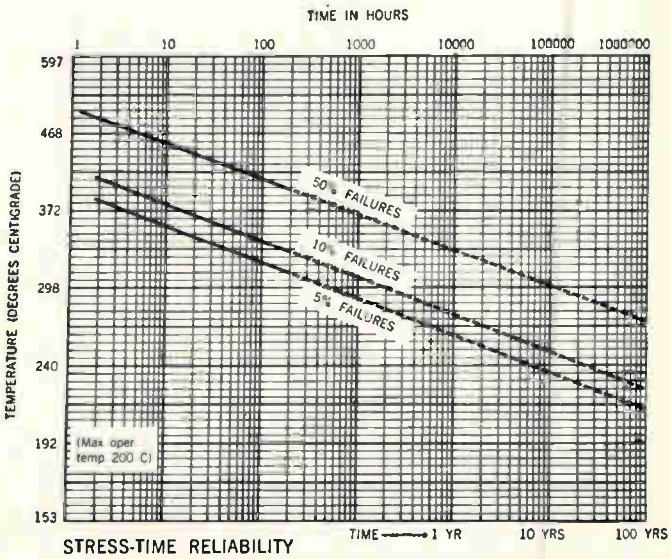
To Contractors and Subcontractors on U. S. Government Projects

THE 1N3471 "PINHEAD"

Western Electric offers this new Microminiature Switching Diode from Laureldale

The 1N3471 is a diffused silicon microminiature switching diode designed for high-speed operation. The size and construction of this pinhead diode suit it for high-density packaging. Controlled manufacturing conditions assure the circuit designer of uniform lot-to-lot diode characteristics with exceptional performance and reliability. (A leaded version of the 1N3471 diode is also available.)





STRESS-TIME RELIABILITY

High-temperature life tests are conducted for 1000 hours to assure (with 90% confidence) a failure rate at 250°C of less than 5% per 1000 hours.

MAXIMUM RATINGS

(Mounting Surface Temp. 100°C)

BV	40 Min.
Power dissipation	0.5 Watt
Tstg	−65°C to +250°C
I_F	120 mAdc

SPECIFIED LIMITS FOR ELECTRICAL CHARACTERIZATION

trr ($I_F = I_R = 10$ mAdc)	2 nsec max.
V_f ($I_F = 10$ mAdc)	1 Volt dc
Is ($V_R = 20$ Vdc)	20 nAdc
C ($V_R = 0$; $f_o = 100$ kc)	3 pf
BV ($I_R = 5\ \mu$Adc)	40 Vdc

The 1N3471 microminiature switching diode can be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to: Sales Department, Room 102, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—WAlker 9-9411.

LAURELDALE PLANT

MAKER OF ELECTRON PRODUCTS
FOR U. S. MILITARY AND SPACE APPLICATIONS

Western Electric

MANUFACTURING AND SUPPLY BELL SYSTEM UNIT OF THE BELL SYSTEM

electronics
November 3, 1961

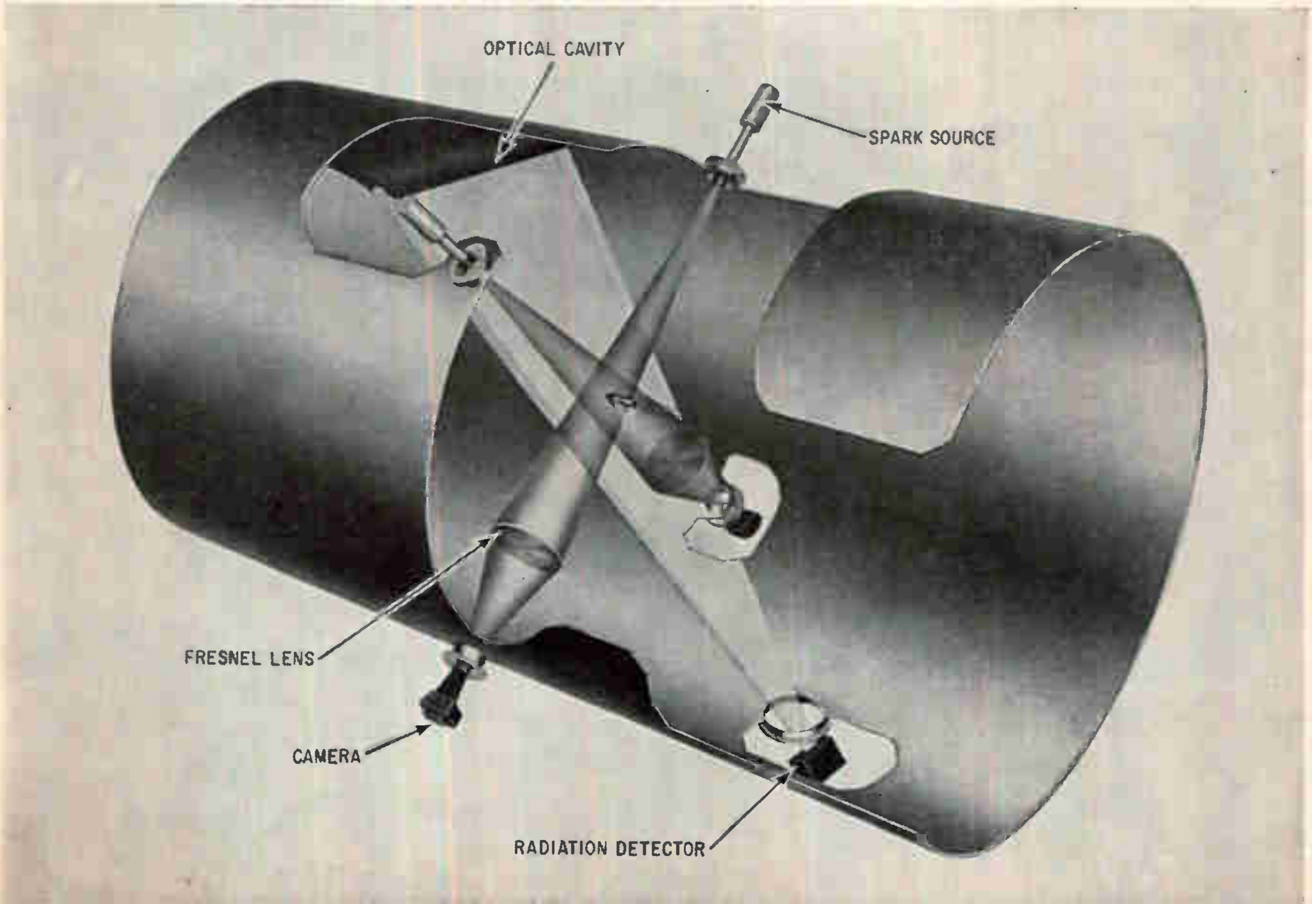
Aerodynamic Measurements

IN A HYPERVELOCITY GUN RANGE

By O. H. BOCK,
P. L. CLEMENS,
ARO, Inc., Tullahoma Tenn., Contract Operators of the Arnold Engineering Development Center, Air Force System Command

THE wind tunnel, in which an aerodynamic model is supported in a moving air stream, is limited in the high-speed, high-altitude flight that it can accurately reproduce. The aeroballistic range, in which a model is launched from a gun through stationary air at preestablished low pressure, allows simulation of flight at extreme altitudes and at speeds approaching escape velocity. Emphasis upon the aerodynamics of escape and reentry has resulted in enthusiasm for testing in aeroballistic gun ranges. Such a range is now under construction within the von Kármán Gas Dynamics Facility at the U. S. Air Force's Arnold Engineering Development Center (AEDC). This hypervelocity range will have a length of 1,000 feet and a diameter of ten feet, and it will be capable of simulating altitudes up to 70 miles. The launcher, which will accompany the range, will produce free-flight

FIG. 1—Dual-axis hypervelocity gun range shadowgraph uses brief-duration point spark sources to silhouette the projectile against an illuminated field. Radiation detector senses the luminous glow of gases enveloping the projectile and triggers exposure. Optical cavity is painted dull black inside and shaped to prevent light rays that enter from leaving



tests at Mach numbers as great as 20.

Although testing of free-flight models in the aeroballistic range is aerodynamically attractive, conventional wind-tunnel measurement methods are inapplicable. Temperatures, pressures, forces and moments imposed upon the model cannot be measured with ordinary transducers and cabling. Ordinary transducers and circuits cannot survive the gross model accelerations incurred during launching. Telemetry systems must replace cabling to permit acquisition of data relating to pressures and temperatures experienced by the unrestrained model. Forces and moments imposed on the model in flight may be inferred from shadowgraph data that disclose the position and angular attitude of the model at successive instants. Development of radio telemetry and optical systems to perform these functions has been undertaken by engineers of ARO, Inc., contract operator of the AEDC. The development work has been conducted in pilot facilities that include a 100-foot-long, 6-foot-diameter, variable-density range and a 140-foot-long atmospheric range.

The shadowgraph is an uncomplicated optical arrangement that uses a brief-duration, point-source of light to provide the background illumination against which the projectile is silhouetted. Such a system appears in Fig. 1, and two shadowgrams are shown in Fig. 2. Resolution of model position and attitude from the shadowgrams is limited by the duration of the capacitor discharge spark that produces the exposure, and by the quality of the shadowgraph optics.

Regardless of the quality of the optics, the shadowgraph is useless unless the spark discharge of the point light sources coincides with the projectile's arrival within the field of view. Customarily, recognition of the projectile and triggering of the spark source is done photoelectrically by a lightscreen device. An electronic photodetector and a light source face one another from opposite sides of the model trajectory. As the projectile passes between the detector and the source the detector is partially shaded, and an electrical pulse triggers the discharge of the shadowgraph spark source. This system has several severe disadvantages:

First, the continuous light source that illuminates the detector must be ripple-free if variations in illumination intensity are not to be mistaken by the detector for passing projectiles.

Second, if a large field of view is to be covered and small projectiles are tested, shading of the detector by the projectiles becomes minute, and the signal-to-noise ratio of the detector limits its ability to recognize passing models.

Third, light from the continuous source exposes the film in the cameras used in the shadowgraph. Camera shutters are left open throughout a model test flight, and shadowgraph exposure is limited by the duration of the spark source capacitor discharge. To prevent fogging the film, elaborate baffling is required, and the light screen detector must be located uprange from the shadowgraph. This introduces another complication in that delay circuits must be used and projectile velocity must be anticipated so that the shadowgram exposure will be synchronized.

Fourth, at high velocities, the flow of gases around the projectile is self-luminoius. The intensity of this self-luminous glow may equal or exceed that of the continuous source that is viewed by the detector. This glowing blob is ill-suited to casting a shadow. Increasing the intensity of the continuous source to overcome the variable luminosity presses the detector

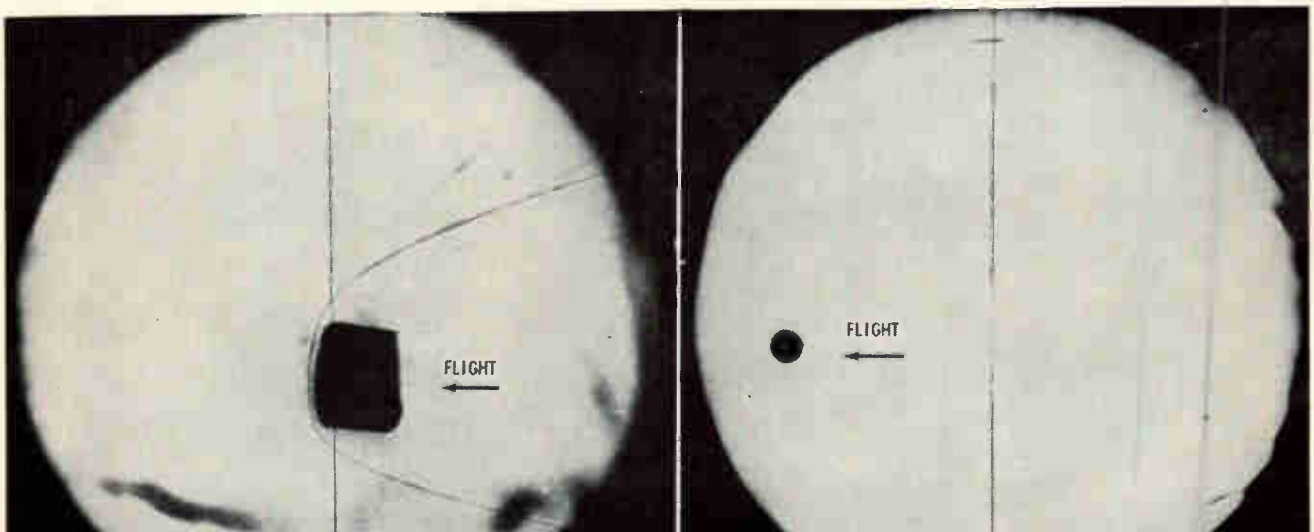


FIG. 2—Shadowgrams show projectiles in flight in rarefied air. Cylindrical projectile (left) 40 mm in diameter and 20 mm long is traveling at 11,500 feet per second at a pressure of 20 mm, simulating an altitude near 17 miles. Half-inch diameter projectile (right), 0.25 inch long, is "stopped" while moving at 26,200 feet per second, at a simulated altitude of 28 miles

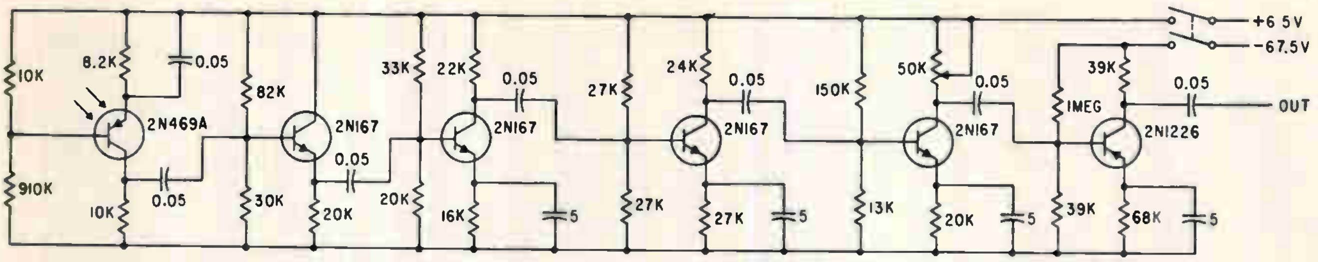
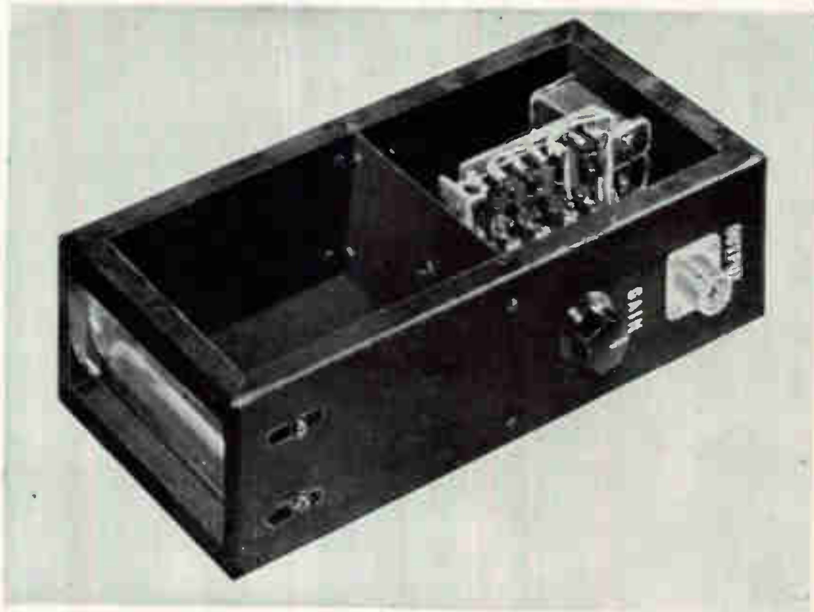


FIG. 3—Circuit of hypervelocity projectile radiation detector provides high-gain amplification of signal from brief, low-intensity light pulse. Baffling (below) confines the detector field of view, and cylindrical lens increases sensitivity



nearer its saturation limit, and sensitivity suffers.

An improved projectile detector system that overcomes these deficiencies has been developed at the von Kármán Gas Dynamics Facility. This detector accompanies the shadowgraph system in Fig. 1. The transistor detector views the darkened interior of an optical cavity. As the projectile with its self-luminous shroud passes between the cavity and the detector, it is recognized and a pulse is generated that triggers the spark source. The use of the cavity insures that no stray light rays, as from muzzle blast and projectile impact, will reach the detector. Since the detector views a dark field rather than a light screen, it may be located to coincide with the shadowgraph, and no delay circuit is required nor is the film in the camera fogged by continuous exposure.

The detector circuit (Fig. 3) uses transistors. The 2N469A phototransistor used as a sensor has a light sensitivity of 7 to 14.9 microamperes per foot candle. The alpha cutoff frequency is near two megacycles, and spectral response, normalized with respect to light intensity, shows a peak in the near-infrared region at 15,000 A. Response drops to 50 percent at about 8,000 A. Circuits beyond the phototransistor comprise a straightforward high-gain pulse amplifier. Amplification is sufficient to elevate the voltage level high enough to ionize a thyratron that initiates the discharge of the spark-source capacitor. Packaging of the detector (Fig. 3) includes simple baffling and a cylindrical plastic lens that increases sensitivity.

The luminous intensity of the gaseous flow that cloaks the projectile diminishes as projectile velocity decreases. Self-luminosity also is lessened as the projectile encounters atmosphere of decreasing density. Thus, there will be a velocity-density profile at which the detector will fail to recognize passing models.

To be useful in instrumenting models for tests in a hypervelocity range, a radio telemeter must withstand the gross launching accelerations imparted by the gun. Recent studies have shown that accelerations as great as 4×10^6 g will be experienced by some projectiles launched in the 1,000-foot hypervelocity range. The telemeter package structure also must withstand pressures as high as 200,000 psi.

The telemeter must be capable of accurately measuring and transmitting many of the parameters conventionally measured in wind-tunnel testing. Multichannel telemetry of a family of such test variables from a single model is desirable inasmuch as data correlation would be facilitated and the number of firings necessary to complete a given test program would be reduced.

The telemeter must be small enough to fit within the aerodynamic model without weakening it excessively. The models used during development are cylindrical. They are of no particular aerodynamic interest but are of value in telemetry development. The telemeter circuit is potted into a cup (Fig. 4) formed of epoxy-impregnated Scotchply tape. The cases of transistors are customarily opened, and the transistor junctions are prepotted to enable them to survive the forces of launching.

A short launcher of smooth 40-mm bore, which uses unheated air to burst a diaphragm, accelerates telemetry models down the 140-foot atmospheric range, which terminates in a sawdust-filled metal

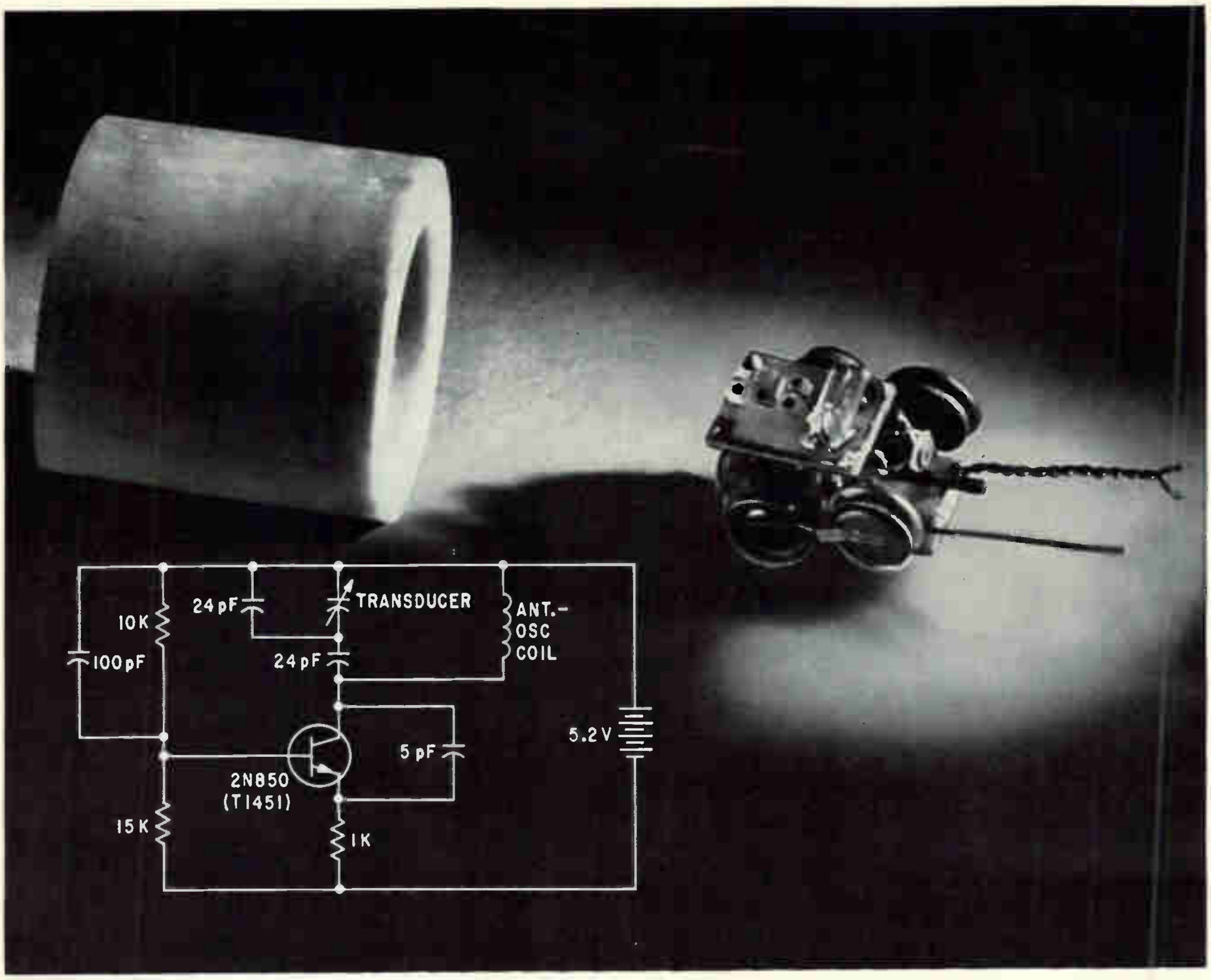


FIG. 4—Pressure telemeter circuit is epoxy-potted into shell. Variable-capacitance transducer senses stagnation pressure. Typical pressure telemeter circuit (inset) uses transducer to modulate a 150-Mc carrier. Antenna-oscillator coil is four turns of 24 Awg wire, 0.16 inch inside diameter

recovery box. Telemetry circuit and construction techniques are first proven with this cold-gas gun and then tested with a combustion gun in the variable-density pilot range. Although it is a low-velocity launcher, the cold-gas gun is capable of applying a peak acceleration of some 400,000 g to a 90-gram telemeter package. The short launcher barrel and cold-gas propellant limit projectile velocities and thereby facilitate projectile recovery. Many projectiles have been launched repeatedly.

Temperatures, heat transfer rates, angular and translational accelerations and pressure are all of sufficient aerodynamic importance to make telemetering them worthwhile. To facilitate the evaluation of test results during the early phases of development, it was considered desirable that the telemetered variable should lend itself well to static calibration and also that it should be one for which inflight, theoretical values might readily be determined. Of all variables considered, stagnation pressure at the model nose appeared most nearly to fulfill these requirements.

Pressure telemeter development follows a five-step evolution:

Step I: Individual telemeter circuit components, encapsulated in epoxy slugs, are subjected to statically applied stresses while functioning in telemeter circuits whose remaining components are undisturbed. This testing allows selection of components least likely to be affected by strains during launching and selection of the orientation, with respect to applied stress, for which each component realizes the least strain. Observation of behavior of epoxies during this testing also permits selective elimination of those that perform badly.

Step II: Complete telemeter circuits, made up of components preselected through Step I testing, are potted and subjected to static testing to insure against intolerable additive influences of stresses simultaneously applied to all components. Again, epoxy performance is examined.

Step III: The complete telemeter, less transducer, is launched, and frequency shift in flight is recorded. This frequency shift is of importance, because it will ultimately appear as a zero shift among telemetered pressure data. Attempts are made, therefore, to minimize the frequency shift and to render it repeatable and predictable.

Step IV: The complete transducer-equipped pressure telemeter is launched with the transducer orifice sealed. In-flight frequency shifts that differ from those observed during Step III testing, are attributable only to peculiarities within the transducer structure. Work is then directed toward minimizing these frequency deviations which, uncorrected, will introduce zero shifts.

Step V: The complete pressure telemeter is launched, with the transducer orifice open to the projectile's stagnation region. Pressure data recovered during flight are compared with theoretical values of stagnation pressure corresponding to the projectile velocities that were measured by six light-screen detectors along the length of the range. These six detectors gate a 4-Kc velocity marker that records simultaneously with the telemetered pressure data. The first light-screen detector is some 10 feet downrange from the end of the gun barrel. Twenty-five feet further downrange is a 6-foot-long cylindrical chamber filled with helium at atmospheric pressure. This chamber provides a discontinuity in pressure readout which enables examination of the telemeter's sensitivity during its flight. The chamber ends are made of tightly stretched rubber diaphragms of dental dam material. As the projectile emerges from the barrel of the gun it actuates a light-screen detector, which initiates the discharge of a group of capacitors through exothermic wires placed again the diaphragms. The exploding wires strip the tightly tensioned diaphragms from the ends of the cylinder. Some ten milliseconds are consumed in removing the dental dam diaphragms. Disparities between sensitivity in flight and sensitivity measured statically prior to launching are noted, and, again, development work is directed toward reducing any differences which might appear. Zero shifts are again analyzed.

A typical telemeter circuit is shown in the Fig. 4 inset. The variable-capacitance transducer, shown as a part of the tank circuit, provides direct modulation of the 150-Mc carrier signal. Capacitors in series and in parallel with the transducer adjust the sensitivity and center frequency of the telemeter. The nominal quiescent capacitance of the transducer is 8 pf, and a pressure excursion of 70 psi produces a 2-pf change in capacitance, causing a frequency shift of some 500 Kc.

A typical oscillogram of pressure, telemetered from a projectile in flight, is reproduced in Fig. 5. The peak acceleration experienced by the model during launching was 215,000 g. The galvanometer trace representing the audio output of the f-m telemetry receiver provides an indication of receiver quieting. Figure 5 (right), a comparison of telemetered stagnation pressures with corresponding theoretical value, evolved from the oscillogram. The notchlike depression in the pressure data resulted from the flight of the projectile through the helium-filled calibration chamber. The telemetered data of Fig. 5 differ from the theoretical curve by some 18 percent of full-scale pressure. The amplitude of the excursion in telemetered pressure, corresponding to the entrance of the projectile into the helium-filled chamber, reveals that sensitivity of the telemeter in flight differed by 11.6 percent from that established during static calibration prior to launching.

Tests made with telemeters that did not contain transducers have shown that the telemeters function in flight following launching at peak accelerations as great as 560,000 g. It has become evident that, at present, the transducer is the most limiting single component within the pressure telemeter.

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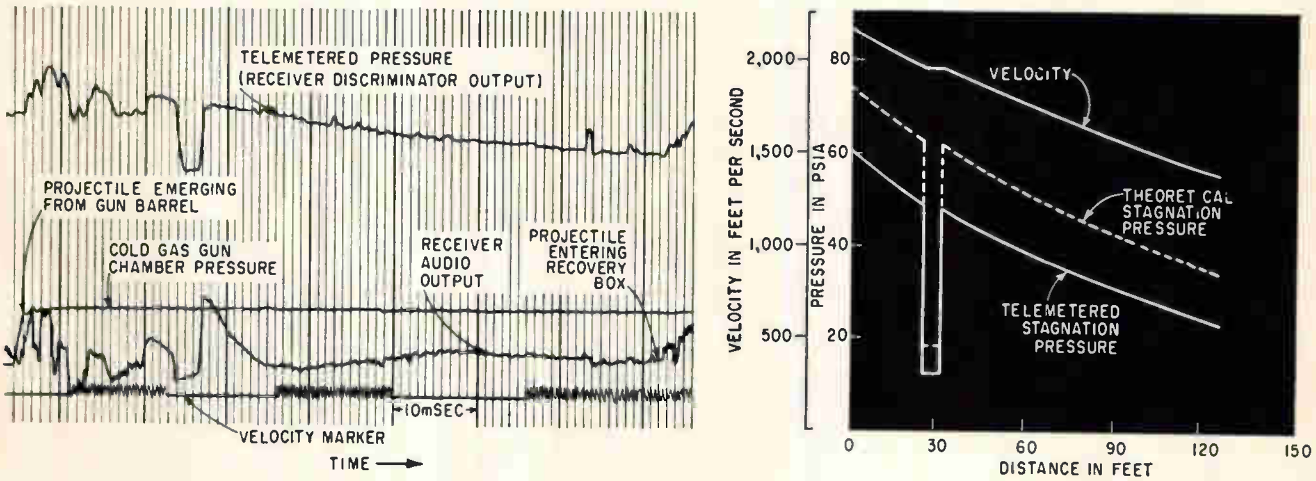
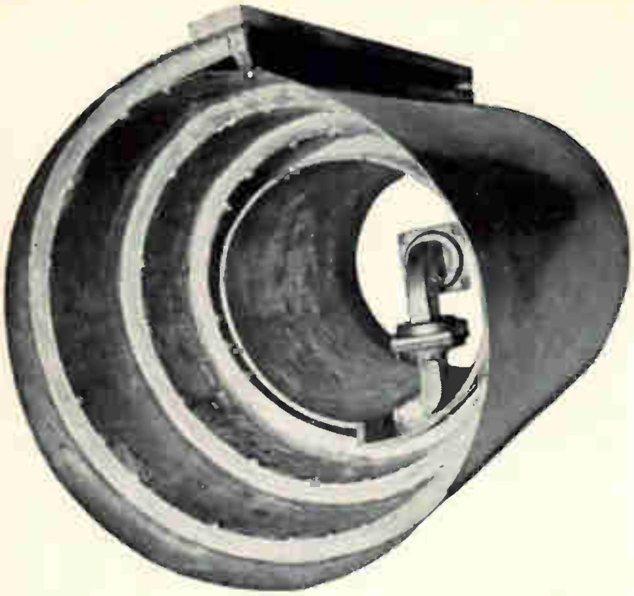


FIG. 5—Oscillogram (left) shows pressure data telemetered from a projectile in flight following survival of peak launching acceleration of 215,000 g. Comparison with theoretical curve (right) shows magnitudes of zero shift and sensitivity errors



Horn operture is on the circumference of the jellyroll cylinder, the feed is inside

JELLY-ROLL

New horn configuration is equivalent to a conventional horn wrapped jellyroll-fashion into a cylinder. Saves space in airborne applications

By LUIS L. OH
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Transport Division,
Renton, Wash.

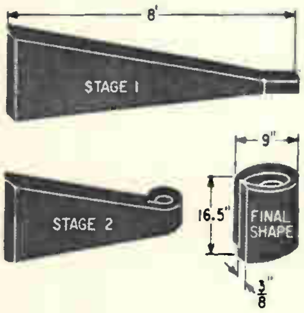

FIG. 1—Horn is rolled from feed-end towards the aperture end

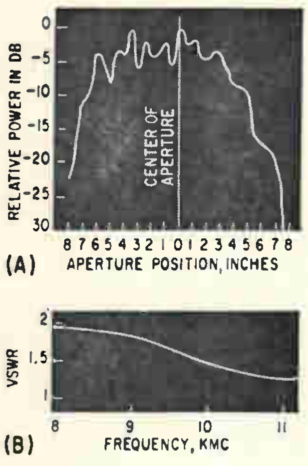

FIG. 2—Power distribution pattern measured across the H-plane of the rolled-up horn (A) and vswr plotted against frequency (B)

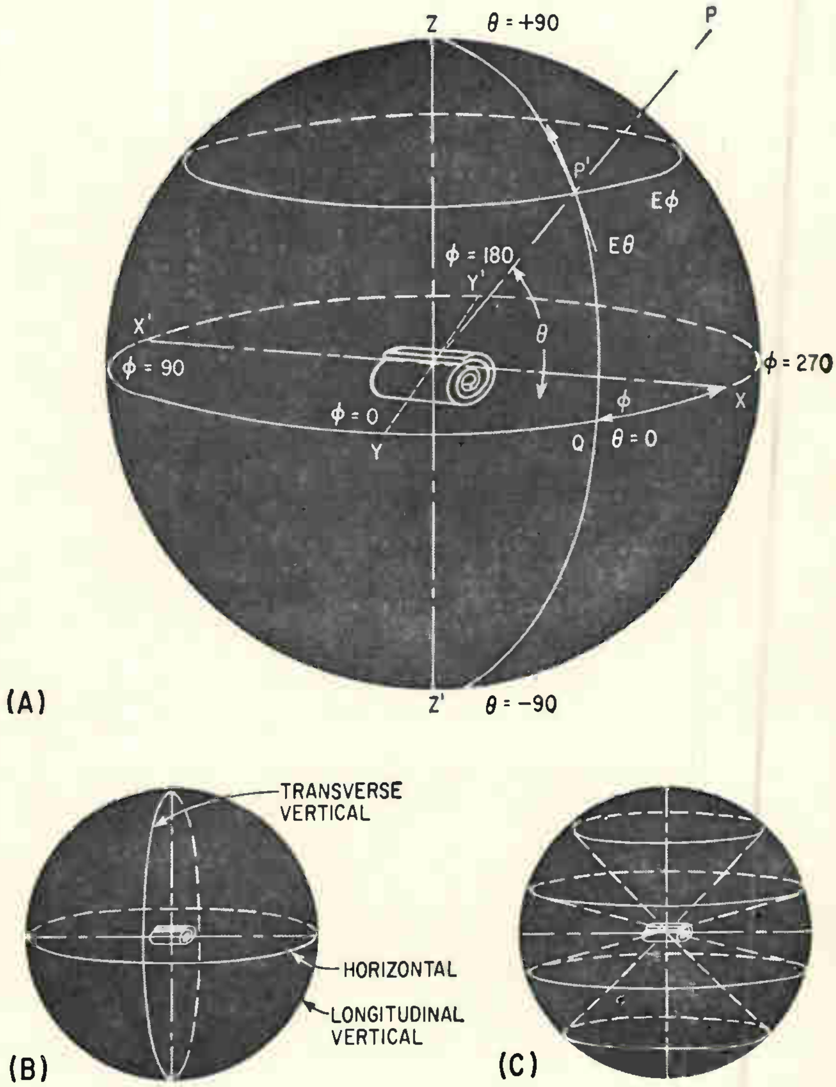

FIG. 3—Coordinate system of the rolled-up horn (A); principal plane radiation patterns (B) and conical radiation patterns (C)

SHAPE Shrinks Horn Antenna

AN ELECTRMAGNETIC HORN antenna is a taper transformer between guided waves and waves in space. The horn itself is a waveguide with a variable characteristic impedance. If the rate of taper is not too great, the reflection from the transition will be small. The shape of the horn may be distorted in various ways, but as long as the change in the cross-sectional dimensions per wavelength of the horn is small, a wide band of frequencies can be transmitted.

One of the simplest and also most useful horns is the straight-sided rectangular horn. This horn may be flared in either or both of the dimensions. A structure in which two of the four sides are flared symmetrically while the others remain parallel is known as a sectoral horn. This sectoral horn provides a straightforward means of producing a fan-shaped beam. Horns flared in the magnetic plane gave a better pattern than those flared in the electric plane. Fan-shaped beam antennas can be used for surface-based and for airborne navigational radar systems, but in spite of the desirable wideband features of sectoral horns they are seldom used in airborne applications because they are usually long and bulky. This is particularly true for horns with a wide aperture. Therefore, a method of reducing the physical size of the horn without impairing its electrical and directional characteristics is desirable.

If the space between the two parallel sides of a sectoral horn is sufficiently small, the length of the horn can be reduced by physically rolling the horn from the feed-end toward the aperture. The external configuration will then be a cylinder and the horn aperture will protrude from the cylinder's circumference. Figures 1A and 1B show an X-band, 8-foot sectoral horn with ⅜-inch by 16-inch aperture that was rolled into a right cylinder 9 inches in diameter and 16.5 inches long.

Figure 2A is a typical power distribution measured across the H-plane aperture of the rolled-up horn. Figure 2B is a plot of the voltage standing wave ratio as a function of frequency. The vswr is below 2:1 from 8 to 11 Gc. The result shows that the electrical characteristics of the horn were not materially modified. Figure 3 is a sketch of the cordinate system used in the radiation pattern measurements. Figure 4 shows the vertical E-plane and horizontal H-plane radiation patterns taken at 8.2, 10.625 and 12 Gc. The wide aperture (H-plane) half-power beamwidth is approximately 5 to 7 degrees with sidelobes 20 db below the mainlobe over a frequency range of 8.2 to 12 Gc. The calculated and the measured beamwidth are in close agreement. The narrow aperture (E-plane) beam was split into two major lobes by the proximity of the horn aperture to the rolled conducting cylinder. The beam split can be minimized by extending the aperture further out from the cylinder and by using a ground plane at the aperture.

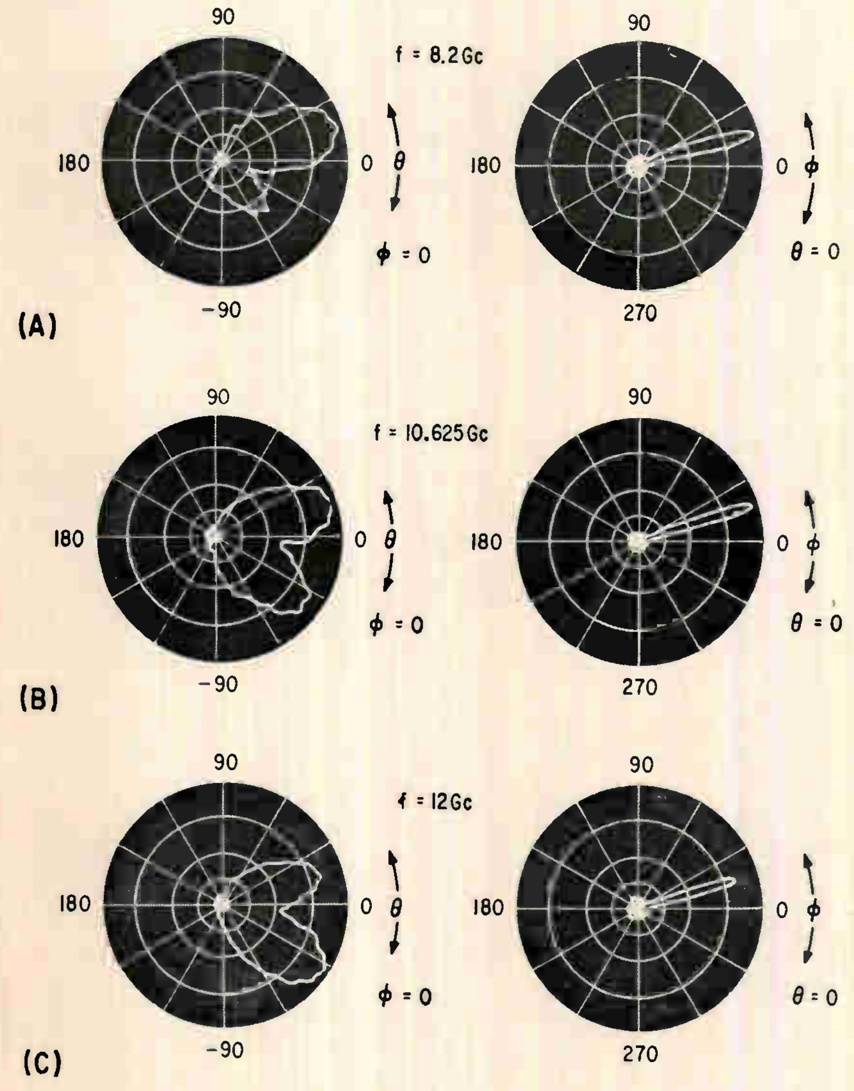

FIG. 4—Radiation patterns for the rolled-up horns over the frequency range 8.2 to 12 Gc. Vertical E-plane patterns left, horizontal H-plane right

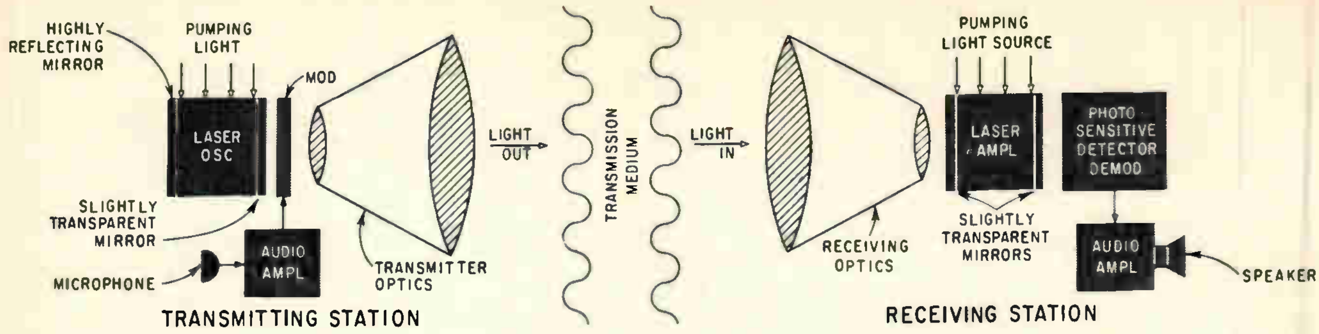

FIG. 1—Laser communications system uses laser amplifier at receiver. Lasers have flat and parallel mirrors (GPL)

LASERS:

DEVICES AND SYSTEMS-PART II

Communications in space, on earth and undersea may soon make use of lasers. Ranging, detection and antisubmarine-warfare applications are also under intense study

By LEON DULBERGER, Assistant Editor, and SY VOGEL, Associate Editor

SPACE COMMUNICATIONS are expected by many researchers to be an area of early practical applications of lasers.

The extremely tight beam produced by the laser, with final tightening obtained by external optical systems, gives it the ability to travel extreme distances with little divergence. The laser output can be focused to a parallel beam where spreading is expected to be less than one foot per mile of travel.

A beam of light from a ruby laser[1], which in principle can be made less than a hundredth of a degree of arc wide, would suffer so little divergence that, for example, it would be concentrated in an area ten miles across when it reached the moon. It would have traveled almost 250,000 miles. Contrasted with this, an ordinary searchlight —assuming like intensity—would place a beam over 25,000 miles wide on the moon. A laser beam directed from earth to a satellite 1,000 miles up, would fall in an area 200 feet across.

It has been suggested that gas lasers may even better these estimates when developed for space technology.

Brightness may approach millions of times that of the sun, on a relative bandwidth basis. Spectral narrowness allows good signal to background ratios to be realized. Compared to microwave systems, laser devices will allow construction of equipment with an antenna only inches across; instead of the several hundreds of feet required at the lower frequencies for roughly similar performance.

It has been suggested that listening systems able to receive intelligence beamed at earth from other civilized planets, at laser frequencies, could now be developed.[2] A search for intelligence at the hydrogen line, a microwave frequency, is now being instrumented. Searching at optical and near infrared using powerful telescopes and photo detectors may reveal another civilization signaling us.

Two systems within reach of our present technology have been discussed[2] and would be feasible even on another planet that had not developed microwave techniques to a high order, but had discovered coherent light techniques first.

One system assumes a 200-inch reflector, the maximum size of present telescopes, a power level of 10 Kw continuous, operation at 5,000 A (angstroms), and a bandwidth of one megacycle. Beam width is 10^{-7} radian.

Alternately, a system using twenty-five lasers of the same specifications as the first design, and having individual four inch tele-

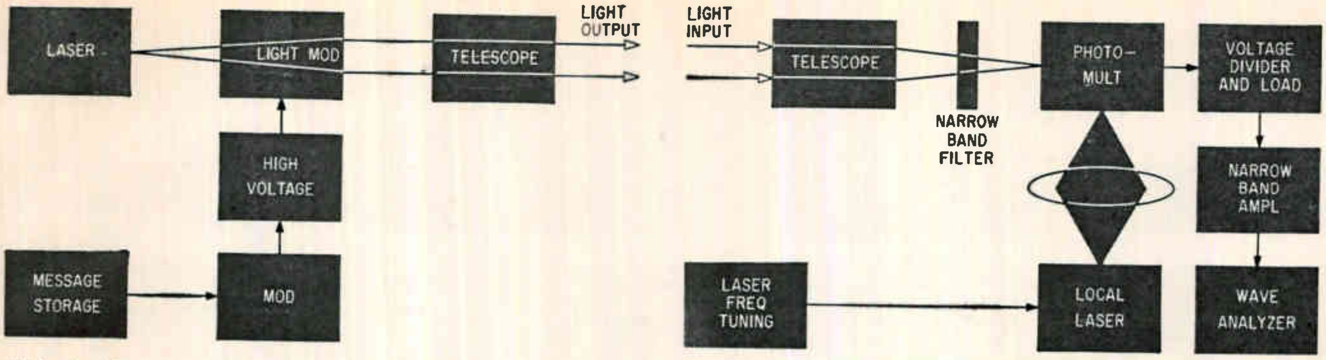

FIG. 2—Laser transmitter beams signals to superheterodyne laser receiver, whose local oscillator is a tunable laser (Minneapolis-Honeywell Regulator Co.)

scopes is considered. Beam width is 5×10^{-6} radians, which is 1 sec of arc. Output of all lasers would be beamed in the same direction. These designs provide a beam operating at optical frequencies with enough power to reach earth from distances of tens of light years.

The problem of detection against background light from the sun associated with the planet of interest, is partly overcome by the narrow frequency of a laser's output. Narrowing the bandwidth to under the 1 Mc assumed would further aid discrimination.

To compete against background, an intensity capable of outshining the sun by some amount must be achieved. The 200-inch lens system would produce an intensity three hundred times that of the sun. The twenty-five lasers using four-inch lenses would produce a beam with intensity three times that of the sun.

To avoid attenuation, operation would best be done from a space platform.

Experiments using light for communication have proved that light beams can be effectively modulated. Last year, Electro-Optical Systems, Inc., Pasadena, Calif., conducted experiments using collected light from the sun and moon, focused to obtain a narrow light beam. The firm has said[3] that it would be possible to use many of their system's principles when substituting a laser as the primary light source. The firm does not now plan work on this exact project.

Their sun-moon experiments using natural light were performed on the desert, with nighttime tests simulating conditions in space. A full moon was used as the light source for night tests. Distances used were made to appear greater by the use of attenuators. Thus, the actual eight-mile separation between transmitter and receiver simulated operation out to 10 million miles. At a range (simulated) of 1 million miles, signal-to-noise ratio was estimated at 16 db. A system of large optical mirrors was used in the desert tests, which were carried out as part of the Air Force's solar communications system research project known as SOCOM.

Recently the Air Force has awarded a contract to American Optical Co., Southbridge, Mass., to study the possibility of using sunlight to excite a laser. A space communication system incorporating a solar collector to excite a laser, would produce a tightly collimated beam on a "free power" basis. Additional power for modulation and other functions might be obtained from solar cells.

Lasers may eventually provide point-to-point communications between space ships, and space ships and platforms. Performance of laser communications systems would require less power than systems using microwaves or incoherent light (or incoherent infrared). One comparison shows that a laser system would require only 10^{-18} watts per bit per sec, whereas a comparable microwave or incoherent-light system would require 10^{-7} w per bit per sec or 10^{-10} w per bit per sec, respectively.[4]

Figure 1 shows a possible communications system using a laser transmitter and a laser amplifier receiver.[5] Audio signals modulate the light emanating from the laser oscillator. The modulated light goes through space to the receiver, whose optical axis is aligned with that of the transmitter. The signal light received is focused on the laser amplifier. Since the amplifier gets just enough pumping light from the pump to bring it near the threshold level of stimulated emis-

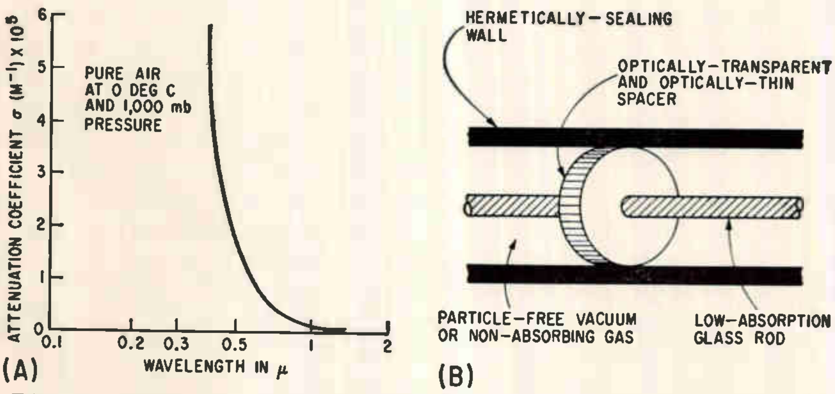

FIG. 3—Attenuation coefficient σ includes absorption, which is generally small, and scatter (A). Speculation on a possible light guide (American Optical Co.) (B)

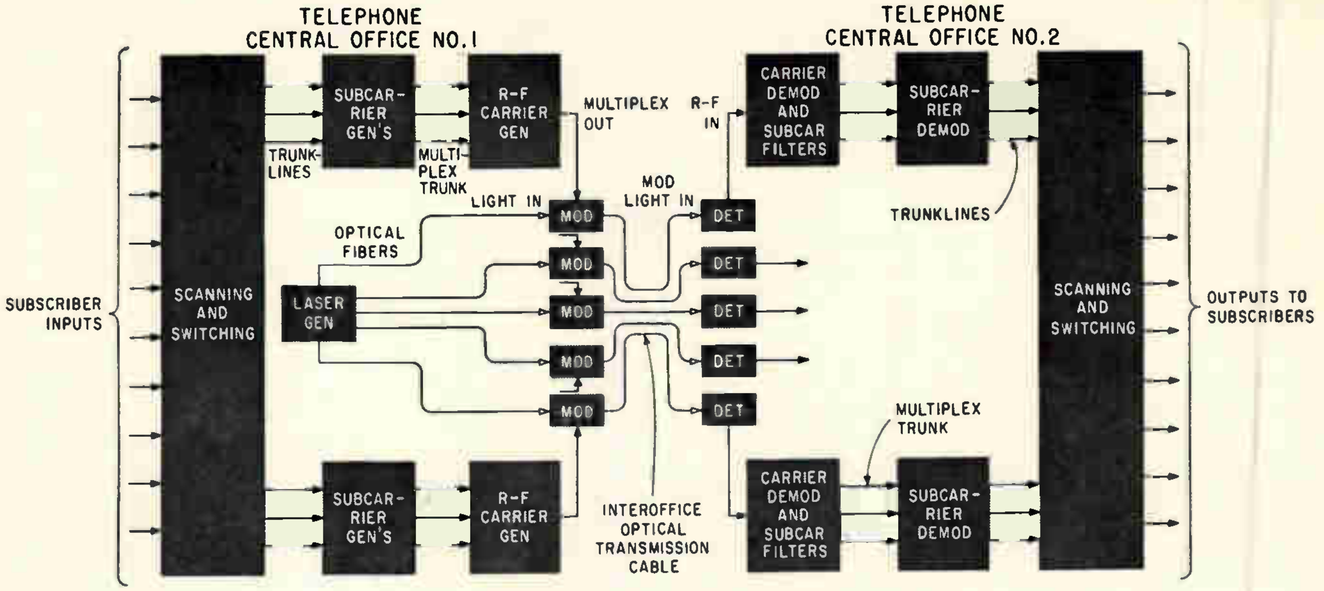

FIG. 4—Possible use of lasers in telephone-exchange systems. Subcarrier and r-f carrier generators drive the light modulators and the detector outputs go to carrier-demodulation subcarrier-filtering blocks

sion (see part I of this series), the input signal causes stimulated emission in the amplifier. The amplified signal goes to a photosensitive detector and demodulator which recovers the audio. Using a laser as an input amplifier gives the receiver a high selectivity because only an input at the right frequency produces enough stimulated emission for laser action to begin. The receiver laser rejects almost all background noise and is nearly immune to jamming since its laser action is caused only by inputs along the optical axis.

In another possible communications system, a laser would be used at the receiver to help detect a modulated signal, rather than as an amplifier only. This laser would operate at a slightly different frequency than the center frequency of the modulated transmitting laser. At the receiver input, a dichroic mirror—a mirror that transmits light of one frequency and reflects light at another frequency—would align the beams from the transmitter and the receiver lasers onto a common mixing path.[6] A photosensitive detector at the end of this path could detect signal modulation by sensing changes in the interference pattern produced by mixing the transmitter laser and receiver laser beams.[6,7] Instead of using a photosensitive detector, an r-f detector could detect the difference frequency created by beating the transmitter-laser beam with the receiver-laser beam in the common mixing path. Demodulation circuits would receive the signal produced by either the photosensitive or r-f detectors and reproduce the transmitted information.[6,7]

Another system would use a photocell to mix the transmitter-laser and receiver-laser beams.[6,7,8] As shown in Fig. 2,[8] these beams would illuminate the face of the photocell, which can serve as a mixing element because it is a nonlinear device. The photocell's output would be an r-f signal containing the transmitted information.

A photo-emissive device could be used to detect laser-transmitted signals directly, that is, without using a laser in the receiver as a front-end amplifier or as a local oscillator.[4,9] The f-m or a-m transmitted light would fall directly on the face of the photocell, whose output would reproduce the modulation. A typical photoemissive device operating at 6,000 A would require 30 quanta of input-signal energy to produce one electron. Since 10 electrons per bit of input information is an adequate ratio for reliable communications, about 300 input quanta per pulse bit of information would be sufficient input for a photoemissive detector.[4] Workers on laser communications would like to use photoemissive devices having better spectral sensitivities at laser frequencies than available photoemissive devices.

Before a transmitting ship sends a laser-transmitted message through space to a receiving ship, the transmitter must determine the receiver's location. Microwave and laser search systems would probably have about the same effectiveness in searching for a target whose bearing from the searcher is completely unknown.[7] This comparison assumes optimum systems having the same average power and the same time allotted to find a target that is close enough so that the radar search unit can get back a recognizable return. Due to its highly-collimated beam, a laser search unit could get recognizable returns from far greater distances than a radar search unit. If the searcher can make a rough prediction as to where the target is, the laser unit has a big advantage over the microwave radar. A combined microwave-laser search unit might comprise an efficient combination.

Optical beacons would greatly assist space ships wishing to establish contact or a rendezvous.[7] A beacon signal could consist of reflected sunlight or thermal radiation or laser pulses. The narrow spectral output of a laser beacon would provide a signal to noise advantage over an incoherent beacon. An optical setup external to the laser beacon might be used to vary the beacon's beamwidth. The target space ship could have an omnidirectional arrangement of light detectors spaced about the surface of the ship; after receiving a call from a transmitter beacon, the detector would command a laser on the target ship to answer in the direction of the call.

EARTHBOUND COMMUNICATIONS. Communications within the bounds of the earth's atmosphere must overcome or circumvent atmospheric attenuation. Water vapor, gas molecules and dust particles are among the attenuating materials in the atmosphere. Figure 3A shows that atmospheric attenuation would be lowest at laser infrared frequencies[10]. Bad weather would prevent long-distance laser communications through the earth's atmosphere in most regions of the world; however, many arid sections have favorable conditions for laser communication.[4] If continuous operation is not a requirement, a laser data link might supplement other continuous-operation links in bad-weather areas by exchanging a high volume of information in the relatively short time permitted by good weather.

A ground-to-ground laser communications system can send the transmitted information along some kind of enclosure to prevent attenuation by the atmosphere. Such ray enclosures must be designed so that long runs do not overly attenuate the signals.

Many workers are thinking of using a pipe-like structure that would carry beams from station to station.[11, 12] Dust particles would be removed from the pipe to limit attenuation. Maintaining a vacuum throughout the pipe, or forcing nonabsorbing, filtered gases into the pipe to keep it under a positive pressure, would help limit signal attenuation. Internal mirrors would direct the beam around curves, and lenses would refocus the beam if required. Signals could be boosted along the way by image intensifiers[6] or amplifier-transmitter lasers.

Available optical fibers are not adequate since they attenuate light by about ¼ of 1 percent per inch. Long transmission lines comprising optical fibers may be possible when materials with low absorption become available.[13]

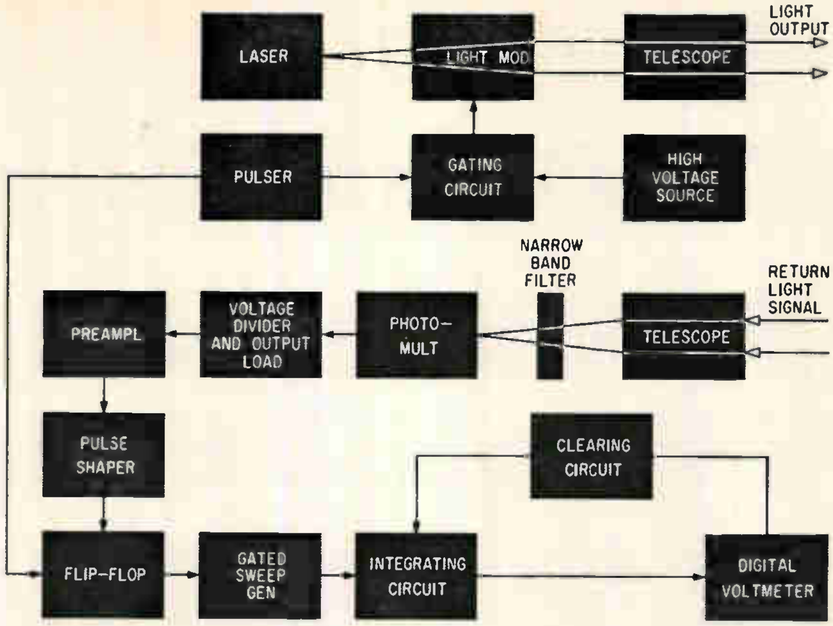

FIG. 5—Pulser gates laser transmitter pulse. Time interval between sending and receiving is read out on digital voltmeter (Minneapolis-Honeywell Regulator Co.)

Figure 3B shows a ray-guide structure that has been mentioned as a possible enclosure for laser signals.[11] The glass rod, made of a yet-to-be discovered composition, would transmit the beam with little absorption. The spacers must be able to pass the beam's field without attenuation.

High-security communications links, such ship-to-ship signaling, could benefit from the high directionality of the laser beam to achieve an interception-proof network. With sufficient power, a laser link could override atmospheric attenuation over short distances in nearly all kinds of weather. The only way an enemy could intercept the beam's message would be to move into its path, unless the beam were so broadened by atmospheric scattering that it could be read outside its path.

A possible laser-operated telephone system is shown in Fig. 4. Subscribers connected to central office number one transmit speech over optical transmission cable to subscribers connected to central office number two. Communication in this example is one way only. The techniques included represent standard telephone practice, and opinions by workers in the laser and optical fields on a possible system configuration. Development would await the proper components and materials. Optical transmission will avoid the expense of using the large number of telephone cables to handle phone traffic as in conventional systems where caller and callee are hooked up all the way by a pair of wires. A multiplexing arrangement sends a large number of conversations over a single line of a yet-to-be-developed optical transmission cable, thus reducing the number of lines required between exchange offices. A similar arrangement, connected to the scanning and switching circuits, would allow conversations to go from central office No. 2 to central office No. 1.

In operation, an input call is switched to an open trunk line by the scanning and switching circuits of central office No. 1. The audio modulates (a-m or f-m is possible) a subcarrier generator whose output is impressed on an r-f carrier that carries a large number of subcarriers. The multiplexed r-f carrier modulates laser light going into a modulator; this light is carried to the modulator by an optical fiber. At central office No. 2, the detector—which may be a multiplier phototube—sends the r-f to a demodulator. Here the subcarriers are filtered out and sent to subcarrier demodulators, where the audio signals are recovered. Scanning and switching circuits that are indicated in the scanning and switching block track down the callee.

LASER RANGING systems can achieve greater accuracies and use less power than comparable microwave systems. Figures 5 and 6 show possible laser-ranging configurations[8]; Fig. 5 shows a ranging system that uses a c-w or quasi-c-w laser oscillator and Fig. 6 shows a ranging system that uses the spiked-pulse output of a ruby laser. In another ranging system that has been proposed, a laser oscillator in the transmitter would emit ranging pulses and a laser in the receiver, rather than a multiplier phototube, would be used to amplify the returned light.[5] A laser-transmitter-to-laser-amplifier combination produces a much narrower beamwidth and much less thermal noise than a comparable microwave ranging system and is relatively immune to external noise. Thus, a laser ranger would require much less power than a radar to obtain a recognizable return from a distant target, provided that signal attenuation due to the transmission medium is not significant; furthermore, a laser system could determine target range, bearing and size with considerable accuracy. For example: one calculation shows that 66 watts (av) of laser-beam power can measure a 160,000-Km distance between space ships to an accuracy of 10^{-6}; another example shows that a space ship 1,600 Km above and parallel to the surface of the moon can determine its velocity vector to a 0.1-percent accuracy, using but 40 mw of laser-beam power.[5] In determining relative velocity, the receiver senses the Doppler-frequency shift of the returned signal by tuning the resonant frequency of its laser amplifier with a variable magnetic field.

A recently-developed ruby-laser ranging system used 1-Kw pulses to determine distances up to 7 miles.[15] Although a 7-mile distance is modest compared to the distances contemplated for space-ranging systems, and the 7-mile-range determination was made on a clear day, this system's performance indicates the feasibility of eventually using lasers to range great distances in space, as well as comparatively short distances on earth. Laser ranging systems can also be used to accurately map areas and measure altitudes.

UNDERSEA LASER systems for applications now dominated by sonar techniques, are being investigated by several firms.[16]

The practical use of light for detection and ranging of submerged objects, and communication between underwater craft depends largely on development of a suitable laser. Operation is required in the blue-green spectrum, for maximum transmission efficiency through sea water. At this writing, a laser operating at this frequency has not been demonstrated.

The use of light, in particular that generated by a laser, will provide greater definition than pulsed sonar in detection and ranging. When used for communication the tight beam will provide secrecy. To achieve practical system operation attenuation of light in the medium must be overcome. Factors responsible for loss include light scattering by suspended particle matter, absorption by materials in the water, and variations in optical density along the light path.[17] The effect of scattering is to raise the background level, and make it difficult to distinguish targets.

Among methods under consideration for range improvement are use of a flying spot illuminator, laser operated, to light a small section of the target at a time. The receiver would employ a flying spot scanner and photo multiplier detector, synchronized with the illuminator. The resulting scatter from target reflections will thus be reduced. Use of spectral filters on the receiver, or a receiving laser, will limit the bandwidth accepted and improve signal to noise ratio.

A laser-operated system will avoid background clutter generated by marine animal noise which plagues sonar and produces false target indications.

Final operating distances of undersea laser systems will be measured in miles. Among military applications are ASW and mine detection. The class of mines that are triggered by sonar equipment used to detect them, would not be activated by light-operated systems.

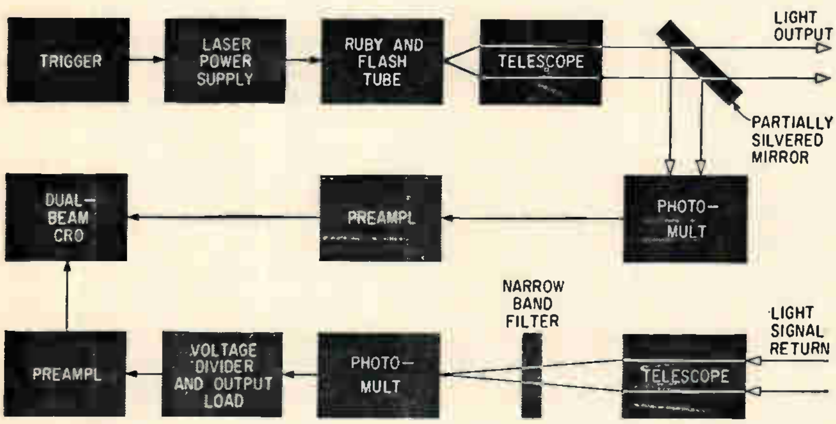

FIG. 6—Since each output pulse of this ranging system is irregular in time and amplitude, a cro readout determines range precisely (Minneapolis-Honeywell Regulator Co.)

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Conventional closed-circuit television system is modified for use as monitoring display. Analog voltages are presented on picture tube as bar graphs and can be compared to go and no-go limits

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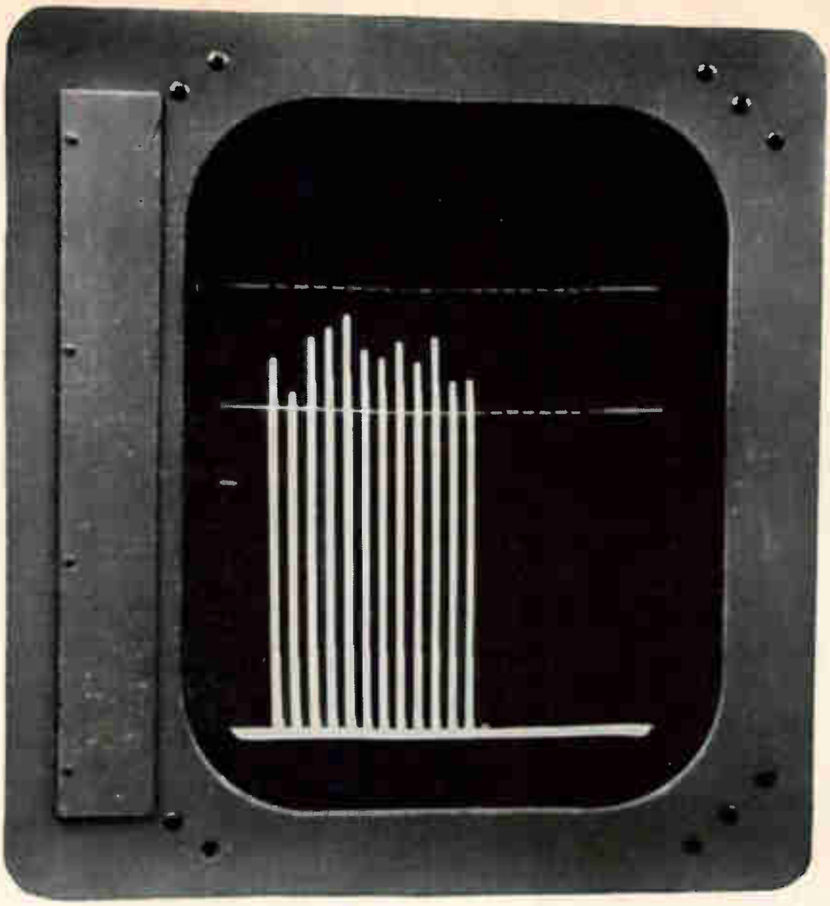


Standard monitor is tuned on end to make bars appear vertical

CONVERTER PRODUCES

Television Bar Display

A QUICK LOOK television display that simultaneously monitors many analog voltages and presents this information as a multiple bar graph is useful in checking the operation of electronic systems. Such a display is described and is an application of closed-circuit television systems.

An electronic commutator produces a waveform of sequential voltage samples with a repetition period of 1/60 second in synchronism with the television sweep. A linear ramp voltage, produced at the television line rate, is used with a balanced amplitude comparator to generate a video pulse whose duration is proportional to the instantaneous value of the input waveform. The video produces a bar graph on the television raster.

Blanking is provided to ensure proper d-c restoring action in the monitor and to eliminate retrace video. Electronic positioning of two reference amplitudes on the television display can be used by the operator as go, no-go limits.

The bar-graph display provides a remote indication of the status of a multiplicity of monitor voltages. These signals are assumed to vary at a slow rate. The operator must receive quick feedback of an out-of-tolerance condition for immediate remedial action.

The bar graph conversion enabled the transmission of the data with only a video cable and monitors that can be part of existing closed circuit television systems. As in a television system, the bar graph can be monitored at a number of stations.

The height of each bar represents an analog voltage with a full scale of five volts. A group of up to 20 bars can be selected by relay controls to determine which parameter, if any, requires corrective control.

The two reference levels electronically positioned on the display are used as references for monitoring those bars whose levels are critical. Electronic positioning of the reference levels eliminates parallax.

The video signal, complete with reference bars and blanking, is compatible with the standard analog video and no change is necessary within the monitor system to produce the bar graph. Relay video switching selects bar graph or picture display.

Figure 1 shows the display conversion system. The sync generator and the tv monitor are conventional to a closed circuit, high resolution system.

Vertical and horizontal sync pulses drive counting circuits and logic to form a set of sampling gates for a commutator. The sampling gates are in synchronism with the television raster. Modular card construction was used throughout. The logic cards use standard TRL logic with the exception of the pulser which has a timing capacitor, internal or external to the card, connected directly to the base of a transistor with a fixed ON bias.

Up to 20 low-frequency analog voltages are commutated onto a common bus by the sampling gates. The commutated signal is then fed to a balanced amplitude comparator, part of an amplitude-to-width converter. The other side of the comparator receives a signal from the saw-tooth generator, which is reset by the television sync. The comparator develops a pulse whose width is controlled by the instantaneous voltage on the common bus. Comparator output is amplified and forms the video for the bar graph. Blanking is introduced before the output stage to eliminate retrace video and to provide a reference level each sweep for operation of the d-c restorer in the monitor.

Television line sync is also fed to delay networks which generate pulses at the proper time to display the reference levels. When these pulses are inhibited by the commutator gate the dashed lines shown in the photo of the display result.

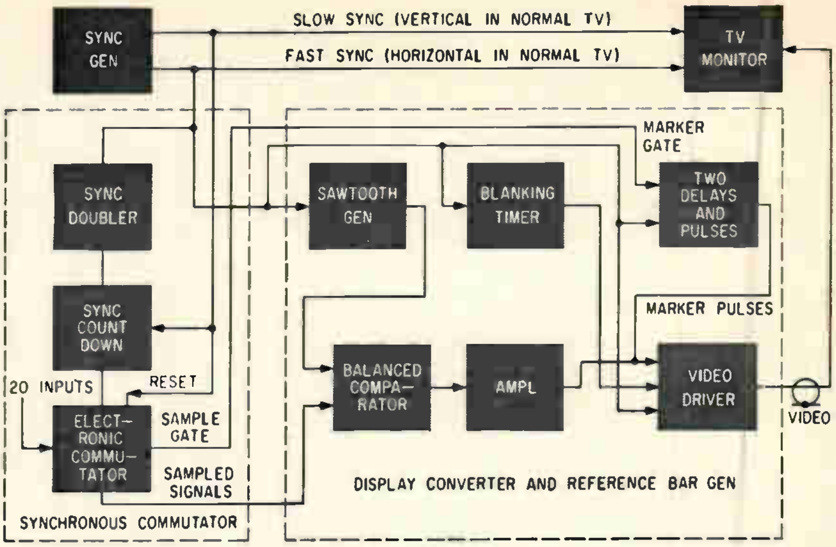


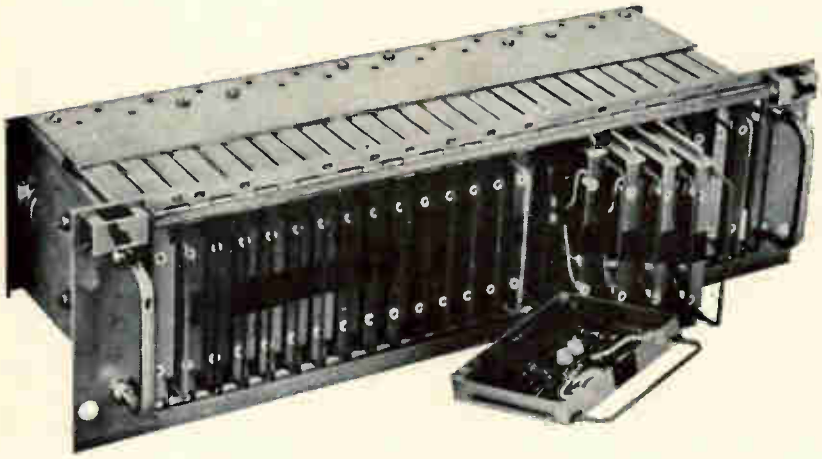
FIG. 1—Display system uses conventional monitor and sync generator

The sync generator and television monitor are conventional to a closed-circuit television system. A high resolution system with a horizontal sweep rate of 25,230 sweeps per second and a vertical sweep rate of 60 sweeps per second is used. This ratio provides two-to-one interlace with an equivalent frame rate of 30 frames per second. The monitor was turned on end to make the bars appear vertical.

The display converter receives a waveform from the commutator which is stationary with respect to the television deflection system. This is accomplished by deriving the sampling times from counted down line sync pulses. Binary and ring counter circuits are reset by the 60-pps sync. By doubling the line rate of 25,230 pps to a rate of 50,460 pps, the jitter introduced in the display by the interlace is eliminated. Line rate doubling is accomplished by OR gating the sync pulses with a set of pulses delayed about 20 microseconds.

The 50,460 pps signal is divided by 32 in a binary counter chain that is reset by the relatively long vertical sync pulse (1,100 μsec). The output (1,577 pps) steps a 20-stage ring counter that is also started by the vertical sync. A timed strobe pulse closes the n^{th} commutator switch, connecting the n^{th} signal to the output. Height of each pulse is equal to the voltage at the corresponding input at the time of the sample. Width of the sample is timed to about 400 μsec or about 10 sweeps. Sync count down and commutation circuits are conventional.

To convert the synchronized waveform into a video signal an amplitude to pulse width converter is used. A linear ramp voltage is developed by charging a capacitor through a constant current source. The ramp level is compared with the synchronized waveform to produce the white to black transition that forms the bars. In Fig. 2 logic inverter Q_1 drives the 2 μsec shortened sync pulse into reset transistor Q_2. Transistor Q_3 is in a constant current circuit that charges C_1 linearly. Fast recovery silicon diode D_1 clamps the voltage to −0.6 v until the discharge pulse is released. The duration of the discharge pulse is adjusted so that the



Modular construction has 25 cards fitting into bucket

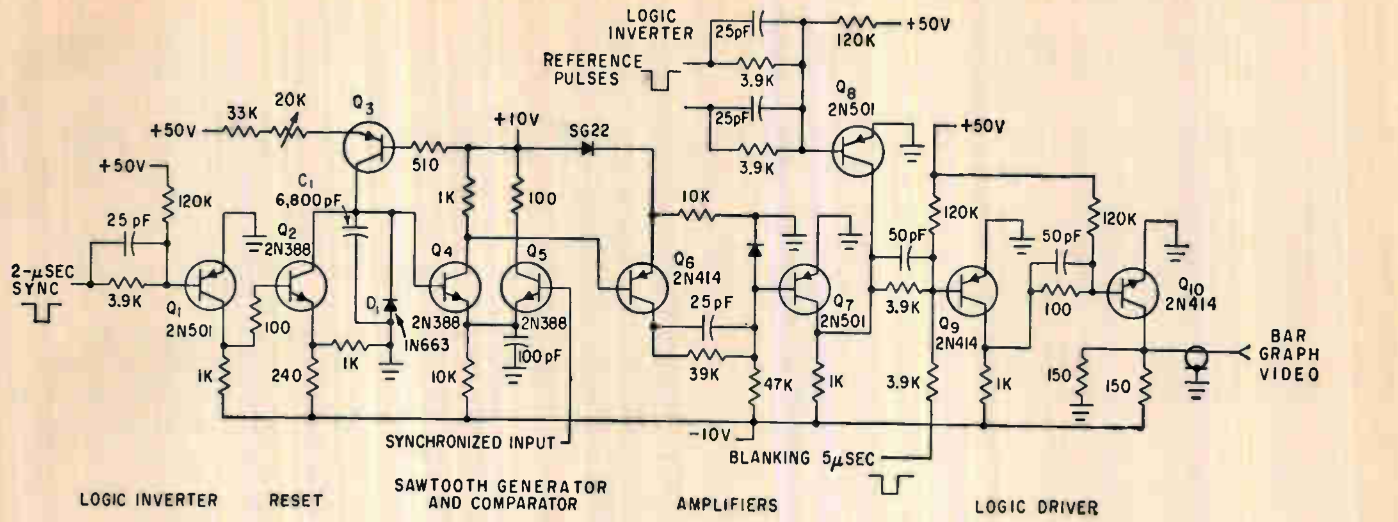


FIG. 2—Circuits include sawtooth generator, comparator, amplifiers, logic gates and driver

ramp crosses zero near the start of the trace on the television monitor.

Balanced comparator Q_4 and Q_5 compares the ramp with the synchronized input. The linear ramp is not loaded until the ramp crosses the input level. Transistor Q_6 and Q_7 amplify the comparator output and restore it to logic switching levels. Transistor Q_8 OR gates the reference pulses onto the video line. A blanking signal inhibits white video at the input to the driver logic formed by Q_9 and Q_{10}. The sync pulse from the sync generator is stretched slightly by a one shot multi to obtain complete retrace blanking.

Adjustments are made by variable potentiometers mounted directly on plug-in cards. These adjustments vary gain by controlling the constant current source; control the zero level by adjusting the discharge pulse duration; vary the blanking duration by adjusting the time constant in the one-shot multivibrator; and vary the height of the reference bars by the delay pulser time constants. For a 10-inch raster, ¼ inch from the bottom of the raster was used as the zero level and full scale was adjusted to 5 volts.

The sweep time in the television system was about 35 μsec, with an additional 5 μsec for retrace. The linear ramp timing capacitor could be discharged in about 1 μsec.

The time delay circuits are a cascade of timers. These are R-C differentiation circuits that hold a logic transistor in its OFF state for a time determined by the time constant and the voltages. A cascade of two delays prevents exceeding the duty factor limitation of the pulsers and enhances the trailing edge for differentiation in another pulser. Logic and differentiation pulsers form the 0.2 μsec pulses for the reference bars.

A gate is generated through a logic inverter which inhibits marker video when the bars are present. This results in reference bars with a dashed appearance and prevents interaction between the bar video and the reference marker video in the output driver.

This display is useful for monitoring the operation of a large electronic system or for production testing. Production testing of complex parts is possible by multiple gaging, which can be monitored by a single operator who can tell at a glance if any portion is out of tolerance.

Industrial operations can be monitored from remote control centers. Temperature, pressure, acidity, salinity, flow, and many other parameters can be observed for quality assurance and safety by a glance at the bar-graph display.

With storage and digital-to-analog converters, the outputs of a computer also can be displayed. An operator can check on the proper operation of the computer and trends in computation can be displayed for interpretation. Fiscal reports or statistical data can be presented simultaneously to many users. The data can be called up and stored electronically while continuous updating by the computer is in progress.

Each bar of the display is equivalent to one d-c voltmeter with limit markings. The television system is more complex than an array of voltmeters but has a number of distinct advantages. A large remote display is possible at a number of locations. The in-line display permits comparison between adjacent bars, and patterns can be recognized as normal or abnormal. The display has dynamic properties with a response frequency higher than conventional meters. Oscillations or instabilities are easily detected and the monitor system can be time shared with conventional closed circuit camera systems. The display converter is, in effect, an electronic camera producing synchronous video.

Use of a television raster permits remote viewing of multiple signals with only video and sync wires connected to the monitor position. The large size display is especially useful in monitoring an electronic system. Failures or marginal operation can be quickly localized by observation of the displays.

The author acknowledges the contribution of P. Caliendo who assisted in the development of the bar-graph display converter.

Computer-Derived Curves

Amplifier designers can save many hours by using these curves. All that is needed are the required values of gain and stability

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A TYPICAL transistor amplifier circuit is shown in Fig. 1A. The two factors of gain and stability are generally given in the circuit specifications. A complex mathematical procedure is required to establish circuit component values.

Equations 1 and 2, for current gain and stability have the same structure as those presently used for analyses of circuits similar to that of Fig. 1A.

The equation for current gain is

$$A_i = \frac{\beta_1 R_g}{R_g + h_{ie} + (1 + \beta_2) R_3} \quad (1)$$

where β is the forward current transfer ratio with the output a-c short circuited, R_g is the parallel combination of R_L, R_1, and R_2 and h_{ie} is the transistor input impedance.

The equation for stability is:

$$S = \frac{1 + (R_3/R_1) + (R_3/R_2)}{1 - \alpha + (R_3/R_1) + (R_3/R_2)} \quad (2)$$

In developing the examples R_L was assumed to be 6,200 ohms; h_{ie} was constant at 750 ohms; and β_1 was made equal to β_2. Other circuit parameters were varied over a range considered typical.

Use of the curves will not only solve most circuit design problems, but will also provide the optimum operating point. Input impedance (Z_{in}) is small compared to R_L and small changes in R_L have little effect on circuit operation. True circuit performance may be calculated from the design equations when R_L differs appreciably from 6,200 ohms.

Two examples will be given. For the first example, the equivalent circuit, with R_3 unbypassed is indicated in Fig. 1B. The equivalent circuit with R_3 bypassed, is indicated in Fig. 1C.

In the first example, assume that a gain of 14 db is desired and that the transistors to be used have a current gain (β) of 70 (R_3 is unbypassed). The first step is to convert the db gain to current gain

$$A_{i\,db} = 20 \log (i_{b1} \sqrt{R_{Q2}})/(i_b \sqrt{R_{Q1}}) \quad (3)$$

or for matched conditions:

$$A_{i\,db} = 20 \log (i_{b1}/i_b) \quad (4)$$

$$A_{i\,db} = 20 \log A_i \quad (5)$$

therefore:

$$A_i = \text{antilog} \frac{\text{Desired gain db}}{20} \quad (6)$$

$$A_i = \text{antilog} (14/20) = 5$$

Refer to the graphs to obtain values of parameters which will provide a current gain of 5, using β values of 70. There are four sets of curves. The difference among the sets of graphs is the ratio of R_1 and R_2. For this example, a ratio of R_1 and R_2 equal to 3 will be used. Current gain is scaled on the left ordinate and stability is scaled on the right ordinate. Curve families for current gain and stability are indicated by solid lines and dotted lines, respectively. Each curve represents a specific value of β indicated on the corresponding curve.

The value of R_2 in kilohms is scaled on the abscissa. The corresponding value for R_1 is obtained by multiplying the R_1/R_2 ratio times R_2. For example: if the ratio is 3 and R_2 = 2,700 ohms, then ratio × R_2 = 3 × 2,750 = 8,250 ohms.

Using the graph of $R_1/R_2 = 3$ and $R_3 = 60$ ohms, point *A* indicates a selected value of $R_2 = 550$ ohms to obtain the desired current gain of 5. Point *B* on the same graph indicates the stability factor obtained under these conditions (with $R_2 = 550$ ohms), which is 7.2.

A circuit is now designed which will provide a current gain of 5 using the following component values; $R_1 = 3R_2 = 1{,}650$ ohms, $R_2 = 550$ ohms, $R_3 = 60$ ohms, and $R_L = 6{,}200$ ohms.

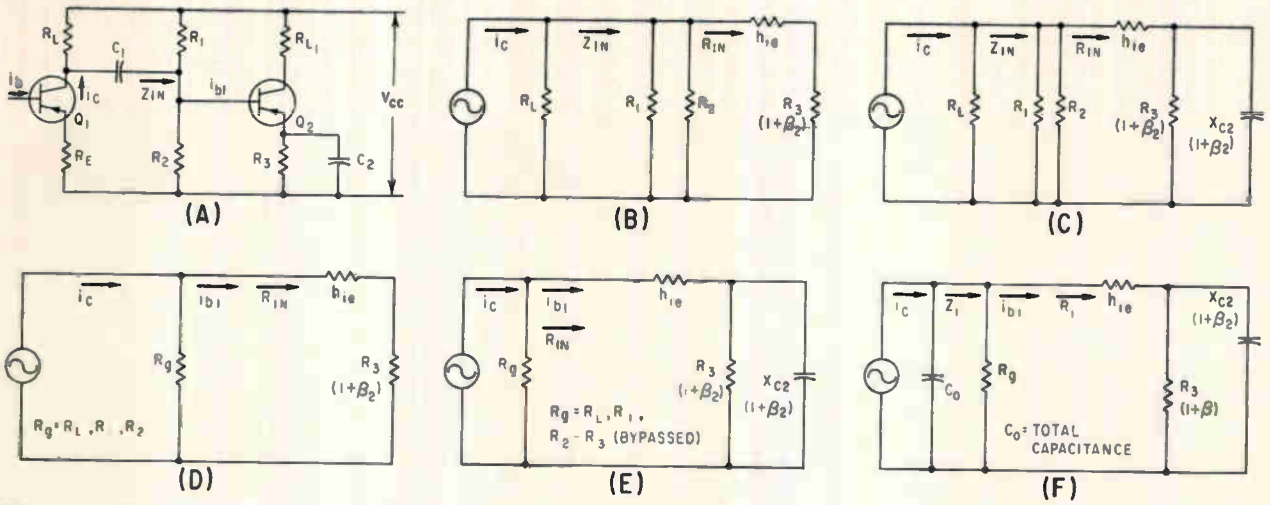
The remaining graphs in the set can be used to obtain alternate parameter values for selection of an optimum circuit. Points *C*, *D*, *E* and *F* on other graphs in the set are located in a manner similar to points *A* and *B*. Table 1 provides a compilation of values of R_1, R_2, R_3 and stability for the points depicted on the graphs. The optimum operating point is represented by the lowest stability factor, which in this case is 6.96 (point *D*). Corresponding component values for the optimum circuit are R_1 =

TABLE I — COMPONENT VALUES FOR $A_i = 5$ (R_3 UNBYPASSED)

$R_1 = 3R_2$ (ohms)	R_2 (ohms)	R_3 (ohms)	Stability
1,650	550	60	7.2
3,150	1,050	120	6.96[a]
6,900	2,300	240	7.45

(a) Optimum circuit

Simplify Transistor Circuit Design



Basic amplifier (A), equivalent with large C_1 (B) and with R_3 bypassed (C). Other equivalents (D), (E) and (F)

$3R_2 = 3{,}150$ ohms, $R_2 = 1{,}050$ ohms (point *C*), $R_3 = 120$ ohms, and $R_L = 6{,}200$ ohms.

In the second example, with R_3 bypassed (Fig. 1C), assume that the required gain at 100 cps is 20 db with a stability of 5 and transistor $\beta = 70$:

$$A_i = \text{antilog}\,(20/20) = 10 \qquad (7)$$

Referring to the graph furnished of $R_1/R_2 = 3$ and $R_3 = 120$ ohms: point *G* indicates a value of $R_2 = 700$ ohms, $R_1 = 3R_2 = 2{,}100$ ohms, $R_3 = 120$ ohms, and $R_L = 6{,}200$ ohms. These component values will provide the desired stability factor of 5. The current gain (point *H*), however, turns out to be 3.5, well below the desired value of 10 indicated in Eq. 7. To obtain the desired current gain, R_3 may be bypassed with a capacitor to produce a network impedance (R_3 and the bypass capacitor in parallel) of approximately 30 ohms. The required capacitor would have a large value for adequate bypassing. Consequently, it would be better to try a new design based on a larger value of R_3.

Using the graph $R_1/R_2 = 3$ and $R_3 = 480$ ohms, point *I* is located. At point *I*, $R_2 = 2{,}800$ ohms, $R_1 = 3R_2 = 8{,}400$ ohms, $R_3 = 480$ ohms, and $R_L = 6{,}200$ ohms. The current gain with these parameters is indicated as point *J*, or 3 which is still much less than the desired value of 10. Again, bypassing R_3 will increase the current gain to the desired value. Solving Eq. 1 will indicate the impedance of the R_3 and bypass capacitor combination for a gain of 10 with $R_2 = 2{,}800$ and $R_1 = 8{,}400$ ohms.

Equation 1 has been graphically solved and plotted. By referring to the graph $R_1/R_2 = 3$ and $R_3 = 120$ ohms, point *K* indicates the desired current gain of 10 with $R_2 = 2{,}800$ ohms. Therefore, the parameters for a current gain of 10 with a stability factor of 5 are $R_1 = 3R_2 = 8{,}400$ ohms, $R_2 = 2{,}800$ ohms, $R_3 = 480$ ohms, R_3 (bypassed) $= 120$ ohms, and $R_L = 6{,}200$ ohms.

It is now necessary to find the value of capacitance to be used in bypassing R_3 to produce a network impedance (R_3 and bypass capacitor in parallel) of 120 ohms with $R_3 = 480$ ohms. The required capacitance at 100 cps is calculated from the basic impedance equation:

$$Z = RX_C \,/\, (R^2 + X_C^2)^{\frac{1}{2}} \qquad (8)$$

substituting $1/2\pi fC$ for X_c and transposing

$$C = \sqrt{\frac{R^2 - Z^2}{Z^2 R^2 (2\pi f)^2}} \qquad (9)$$

$$C = \sqrt{\frac{480^2 - 120^2}{120^2 \times 480^2 (6.28 \times 100)^2}}$$

$$C = 12.85\ \mu\text{F}$$

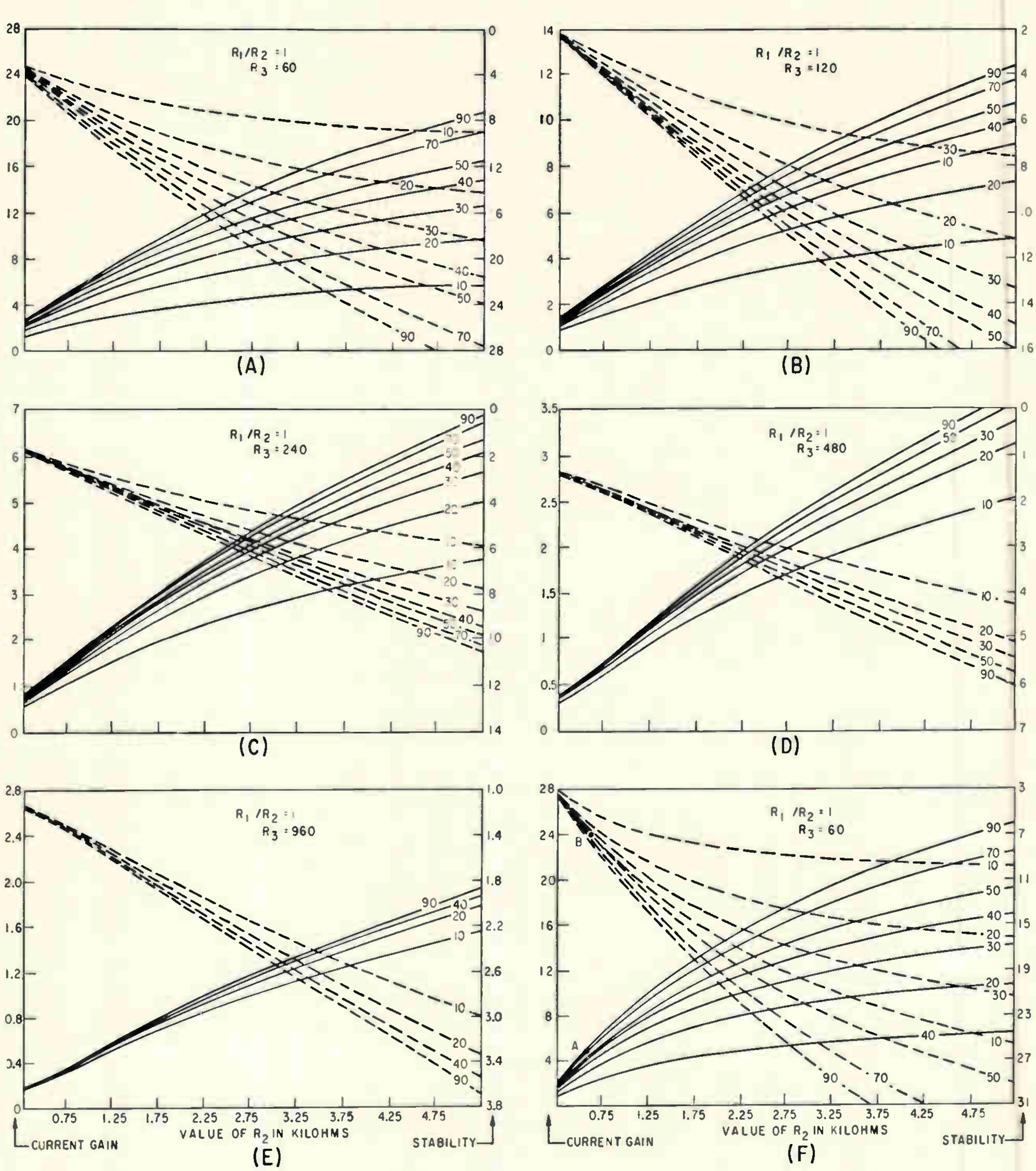
A capacitor with a value 12 μf or 15 μf is readily available. Either one will give satisfactory results.

Note that the equations used are linear, which makes it possible to interpolate and extrapolate between sets of curves.

The following portion of the article presents the various parameters of transistor amplifiers (and their derivations) which are frequency-sensitive.

From Fig. 1A, equations are derived for Z_{in}, i_{b1}, R_{in} and the current gain of i_b and i_{b1}. Frequency response is investigated and equations derived, from which value for C_1 and C_2 may be calculated.

Two equations are derived for Z_{in}. The first equa-



tion is without C_2 bypassing R_3. If we assume that C_1 is large and its effects upon the circuits can be neglected, the equivalent is shown in Fig. 1B.

$$Z_{in} = (Z_A R_{in})/(Z_A + R_{in}) \qquad (10)$$

where

$$Z_A = (R_1 R_2)/(R_1 + R_2) \qquad (11)$$

and

$$R_{in} = h_{ie} + (1 + \beta_2) R_3 \qquad (12)$$

where h_{ie} is the transistor input impedance and β is the forward current transfer ratio with the output a-c short circuited.

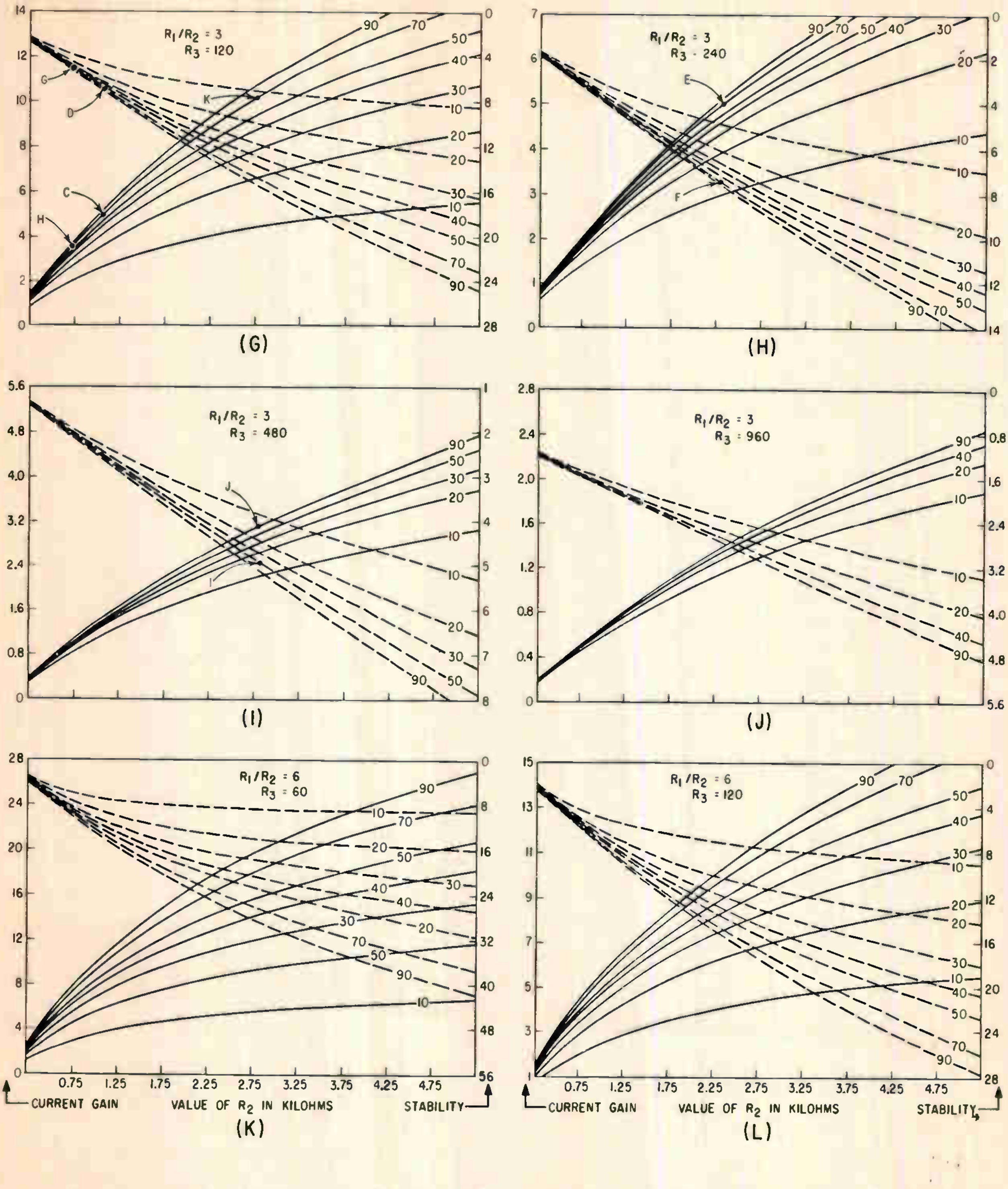
Substituting Eqs. 11 and 12 into Eq. 10

$$Z_{in} = \frac{[(R_1 R_2)/(R_1 + R_2)]\,(h_{ie} + (1 + \beta_2) R_3)}{[(R_1 R_2)/(R_1 + R_2)] + h_{ie} + (1 + \beta_2) R_3} \qquad (13)$$

Simplifying Eq. 13

$$Z_{in} = \frac{R_1 R_2 h_{ie} + R_1 R_2 R_3 (1 + \beta_2)}{R_1 R_2 + R_1 h_{ie} + R_2 h_{ie} + R_1 R_3 (1 + \beta_2) + R_2 R_3 (1 + \beta_2)} \qquad (14)$$

A second Z_{in} will now be derived with R_3 bypassed. Figure 1C shows the equivalent and R_{in} becomes



$$R_{in} = h_{ie} + (1 + \beta_2)\,[(R_3 X_{C2})/(R_3 + X_{C2})] \qquad (15)$$

Simplifying and substituting $1/j\omega C_2$ for X_{C2}

$$R_{in} = h_{ie} + [(1 + \beta_2)\,R_3]/[1 + j\omega\, C_2 R_3] \qquad (16)$$

Substituting Eqs. 16 and 11 into Eq. 10 and simplifying

$$Z_{in} = \frac{R_1 R_2 h_{ie} + R_1 R_2 R_3 (1 + \beta_2)}{R_1 R_2 (1 + j\omega\, C_2 R_3) + (R_1 + R_2)} \qquad (17)$$

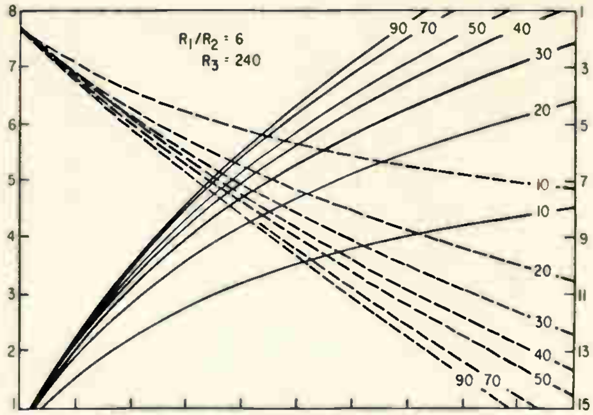
Base current of Q_2 will now be derived and to facilitate the resultant equations, Fig. 1B will be used. The parallel combination of R_L, R_1 and R_2 will be designated as R_g and i_{b1} and therefore can be written as

$$[(1 + j\omega\, C_2 R_3)\, h_{ie} + (1 + \beta_2)\, R_3]$$
$$i_{b1} = i_c - [(i_c R_{in})/(R_g + R_{in})] \qquad (18)$$

where $i_c = \beta_1 i_b$ and R_{in} is as given in Eq. 12, substituting Eq. 12 into Eq. 18 and simplifying

$$i_{b1} = \frac{\beta_1 i_b R_g}{R_g + h_{ie} + (1 + \beta_2)\, R_3} \qquad (19)$$

Now write the equation for current gain for the



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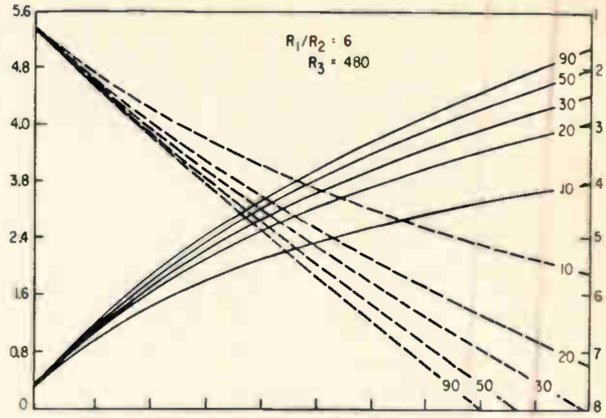

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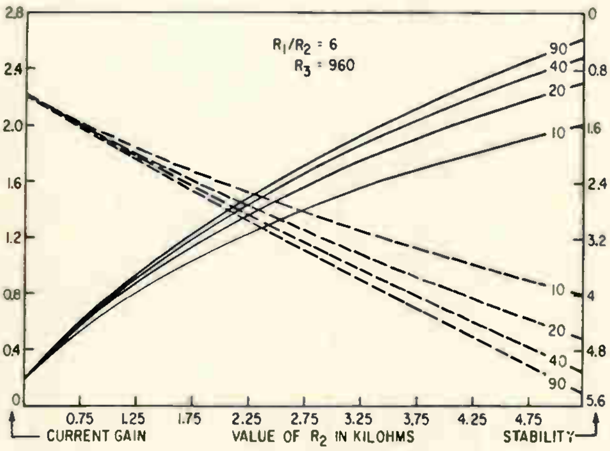

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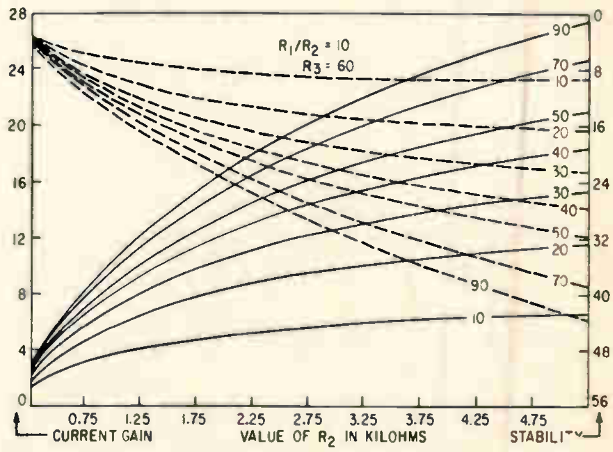

(P)

unbypassed condition as

$$\text{current gain} = A_i = i_{b1}/i_b \qquad (20)$$

substituting Eq. 19 into 20 and simplifying

$$A_i = \frac{\beta_1 R_g}{R_g + h_{ie} + (1 + \beta_2) R_3} \text{ (Same as Eq. 1)} \qquad (21)$$

with current gain expressed in db

$$A_i = 20 \log (i_{bi}/i_b) \qquad (22)$$

where i_b and i_{b1} flow into equal impedances or

$$A_i = 20 \log [(i_{b1} \sqrt{R_{Q2}})/(i_b \sqrt{R_{Q1}})] \qquad (23)$$

where $R_{Q1} = h_{ieQ1} + (1 + \beta_1) R_e$ (Fig. 1A) and $R_{Q2} = h_{ieQ2} + (1 + \beta_2) R_3$ (Fig. 1B) for the unmatched condition.

Calculate the current gain for the bypassed condition. Figure 1E is the equivalent circuit and R_g is again comprised of R_L, R_1 and R_2 in parallel and i_{b1} may be expressed as Eq. 18 where R_{in} is as given in Eq. 16. The current gain may now be calculated by substituting Eqs. 16 and 18 into Eq. 20.

$$A_i = \frac{(1 + j\omega C_2 R_3)\, \beta_1 R_g}{(1 + j\omega C_2 R_3)(R_g + h_{ie}) + (1 + \beta_2) R_3} \qquad (24)$$

The equations used to calculate the value of C_1 and C_2 which will determine the cutoff frequency of the stage will now be derived. The cutoff frequency is defined as that frequency in which the response of the stage is down 3 db at the high and low ends of the interested frequency spectrum. The first equation to be derived will be for C_2, with the effects of C_1 assumed to be negligible. A general equation which is frequently used to calculate the 3-db point on a gain versus frequency curve is given by

$$G_{3\,db} = \frac{K\omega}{1 \pm j1} = \frac{K\omega}{|\sqrt{2}|} = 0.707\, K\omega \qquad (25)$$

where K is a constant.

This equation may be used with Fig. 1E to calculate the cutoff frequency. From Fig. 1E $i_{b1}/i_e = R_g/R_g + R_{in}$ or

$$\frac{i_{b1}}{i_b} = \frac{R_g}{R_g + h_{ie} + \dfrac{[(1 + \beta) R_3}{1 + j\omega C_2 R_3]}} \qquad (26)$$

where R_{in} is as given in Eq. 16.

Equation 26 may be placed in the form of Eq. 27.

$$\frac{i_{b1}}{i_e} = \frac{R_g (1 + j\omega C_2 R_3)}{\underbrace{R_g + h_{ie} + (1 + \beta) R_3}_{A} + \underbrace{j\omega C_2 R_3 (R_g + h_{ie})}_{B}} \qquad (27)$$

Equation 27 has the form of Eq. 25 and the gain

All gone

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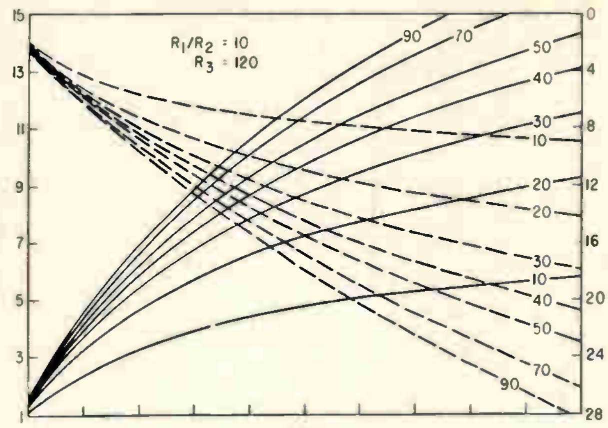

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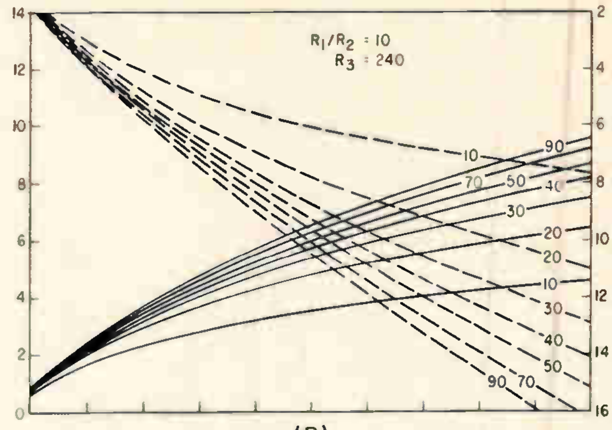

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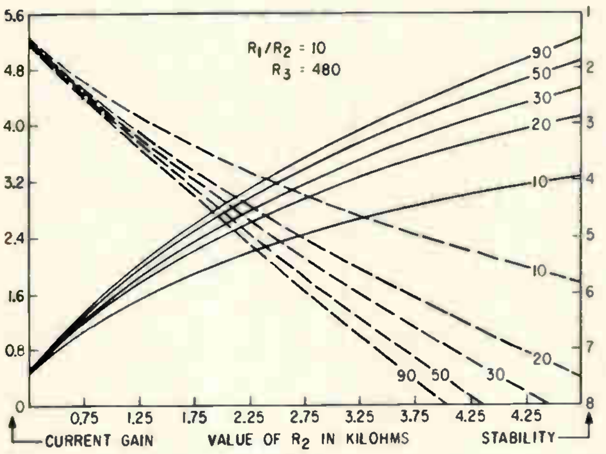

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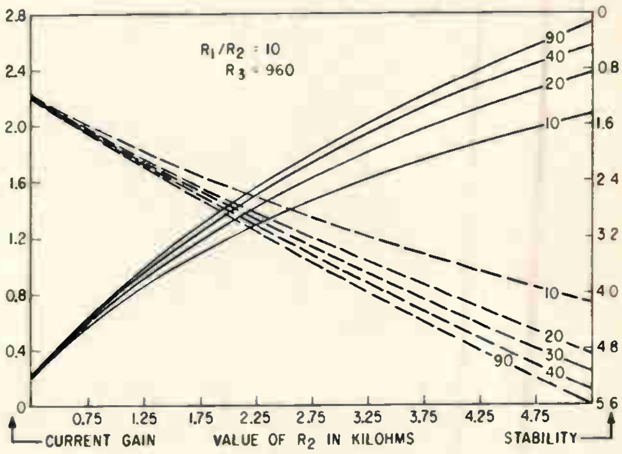


(T)

will be down 3 db when the A and B terms approach unity. By setting term A equal to term B, solve for ω at the 3-db point.

When using this approach to obtain ω at the 3-db point it must be assumed that $C_2 R_3 >> C_2 R_3 (R_g + h_{ie}/R_g + h_{ie} + (1 + \beta) R_3$ which is a valid assumption in most cases. At the 3 db point, ω is then given by

$$\omega = \frac{R_g + h_{ie} + (1 + \beta) R_3}{R_3 C_2 (R_g + h_{ie})} \qquad (28)$$

rearranging terms

$$C_2 = \frac{R_g + h_{ie} + (1 + \beta) R_3}{R_3 \omega (R_g + h_{ie})} \qquad (29)$$

The frequency response at the low end of the band will be down 3 db owing to C_1 (Fig. 1A) when

$$X_{C1} = Z_{in} \qquad (30)$$

where Z_{in} is as given in Eq. 17. Substituting Eq. 17 and $1/\omega C_o$, in Eq. 30

$$\omega = \frac{R_1 R_2 + h_{ie} (R_1 + R_2) + R_1 R_3 (1 + \beta) + R_2 R_3 (1 + \beta)}{R_1 R_2 h_{ie} C_1 + R_1 R_2 R_3 (1 + \beta) C_1 - R_1 R_2 R_3 C_2 - (R_1 + R_2) (C_2 R_3 h_{ie})} \qquad (31)$$

Rearranging terms of Eq. 31

$$C_1 = \frac{R_1 R_2 + (R_1 + R_2) [h_{ie} + (1 + \beta) R_3] + C_2 \omega R_3 [R_1 R_2 + h_{ie} (R_1 + R_2)]}{\omega R_1 R_2 [h_{ie} + R_3 (1 + \beta)]} \qquad (32)$$

Transistors used for audio frequencies usually have a cutoff frequency 10 times the cutoff frequency desired. When using these transistors it may be assumed that the upper frequency limit is determined by the output capacitance of the transistor and the associated stray capacitance. The total capacitance will be designated as C_o. Assume that C_2 presents a short circuit at this frequency and its effects can be ignored. The equivalent circuit is shown in Fig. 1F, and at the 3-db point X_{Co} will be equal to Z_i where

$$Z_i = \frac{R_g h_{ie}}{R_g + h_{ie}} \qquad (33)$$

or

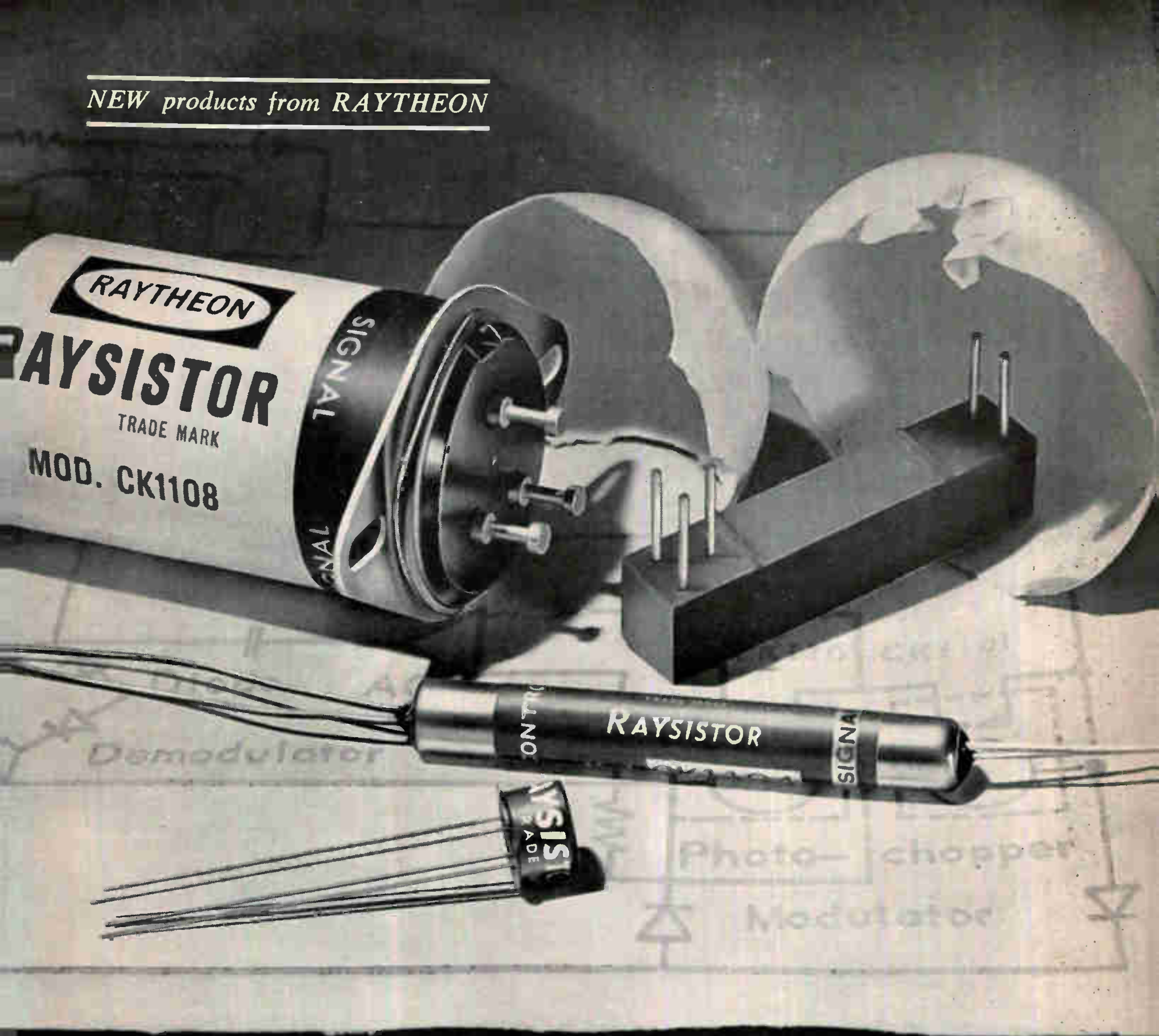
$$X_{Co} = Z_i$$

$$\frac{1}{\omega C_0} = \frac{R_g + h_{ie}}{R_g + h_{ie}} \qquad (34)$$

simplifying and rearranging terms

$$\omega = \frac{R_g + h_{ie}}{R_g h_{ie} C_o} \qquad (35)$$

NEW products from RAYTHEON



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Humans Hear Transmitted R-F Pulses

EXPERIMENTS have established that the human auditory system can respond to electromagnetic energy at radio frequencies. The r-f energy is detected directly without requiring conversion to acoustic energy for perception.

These findings result from a continuing series of experiments at the General Electric Advanced Electronics Center at Cornell University. They were reported at the Fourth International Conference on Medical Electronics in a paper by A. H. Frey.[1,2] (See Electronics, p 41, Aug. 21.)

The r-f sound has been described as a buzz, ticking, hiss or knocking, depending on such factors as pulse width and repetition rate of the pulse transmissions used. No intelligence was included in the r-f pulses, and the experiments indicate that the r-f sound is the incidental modulation envelope of each pulse, as in Fig. 1.

Difficulty was encountered in matching the r-f sound to ordinary acoustic energy, and subjects were unable to match it to a sine wave or to white noise. A variable bandpass filter was connected to an audio amplifier that was pulsed by the transmitter. When the subjects eliminated all frequencies below 5 Kc and extended high frequencies as far as possible using the filter, they were reasonably satisfied. However, they always wanted more high-frequency components, although high-frequency response of the tweeter used was good.

The desire for higher frequencies suggests a phenomenon analogous to that in which people see farther into the ultraviolet range when the lens is removed from the eye. The mechanical transmission system of the ossicles may be unable to respond to as high frequencies as the rest of the auditory system. Since the r-f energy bypasses the ossicle system but the audio energy does not, this difference may account for the dissatisfaction of the subjects in matching the sounds.

Some deaf subjects who could hear audio above 5 Kc either by bone or air conduction also hear the r-f sound. The threshold in the audiogram in Fig. 2A is about the same power level as for subjects with normal hearing. However, the subject of the audiogram in Fig. 2B with normal hearing could not hear the r-f sound. Therefore no conclusions were made relating hearing defects to perception of r-f sound.

The threshold for perceiving r-f sound is indicated in Table II. The critical factor is peak rather than average power density. Probably either the electric or the magnetic field alone is responsible for the effect rather than both combined. Peak field strengths in Table II are not very high. It was concluded that if ambient noise level were not so high, threshold field strengths would be much lower.

The curve of threshold energy as a function of frequency in Fig. 3 suggests a curve of r-f penetration into the head, such as that in Fig. 4 calculated from frequency.[3] Data from these tests indicate that calculated penetration may be accurate at higher frequencies but penetration is greater than calculated at lower frequencies on this model.

Noise level was 70 to 90 db and antinoise stopples were used for all measurements. However ear plugs are not necessary even with noise level above 90 db, but ambient noise seems to mask the r-f sound to some extent. Obtaining the thresholds in high ambient noise is unusual, but r-f sound threshold can be determined theoretically with the subject

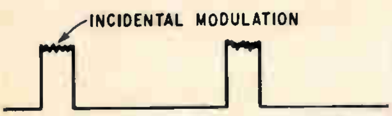

FIG. 1—Incidental modulation envelope of transmitted pulses is probably the r-f sound

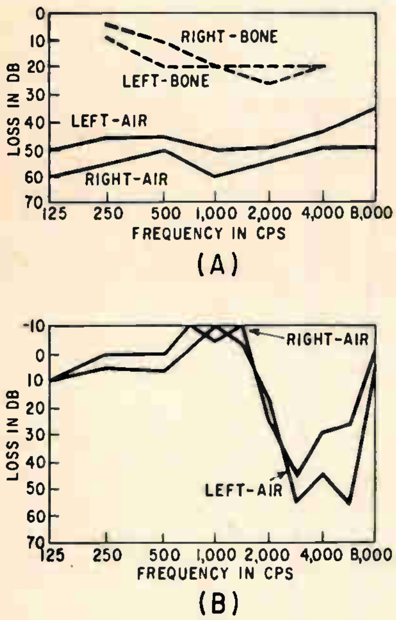

FIG. 2—Audiogram of deaf subject (A) who could hear r-f sound and subject with normal hearing (B) who could not

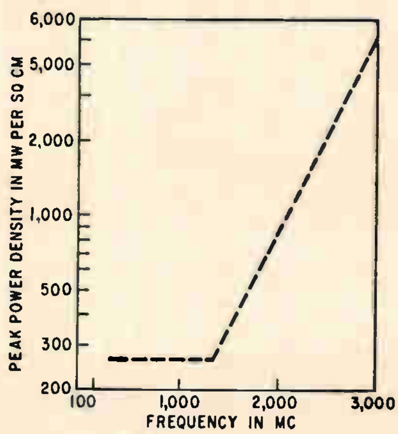

FIG. 3—Threshold energy as a function of frequency suggests that the r-f penetrates the head

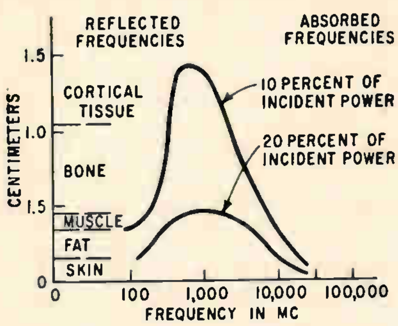

FIG. 4—Power distribution in forehead model neglects resonance effects and considers only first reflections

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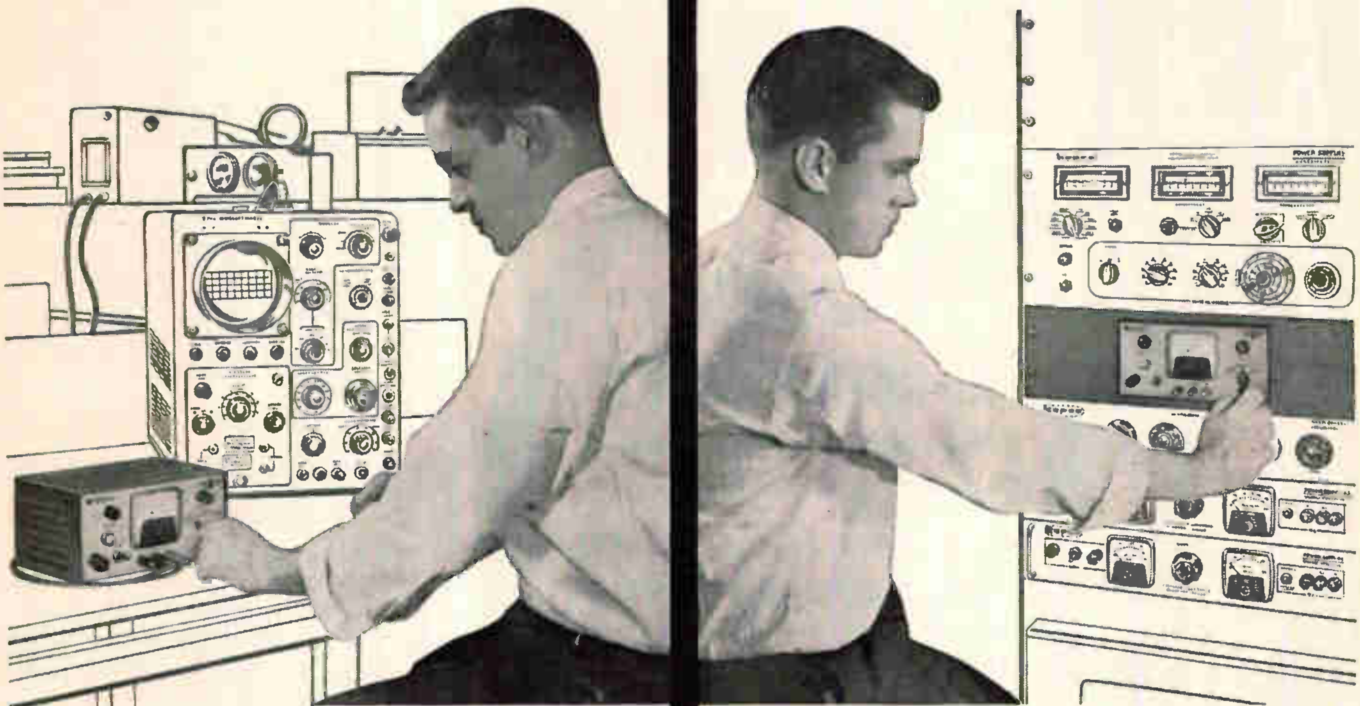

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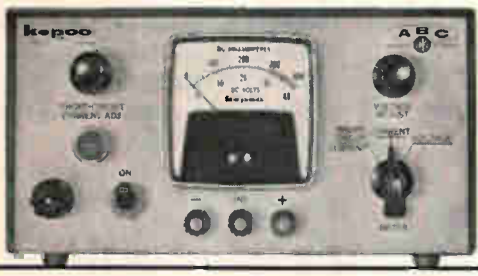

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ABC 40–0.5	0–40	0–500ma.	4¼″	8 5/32″	9⅝″	**$139.00**
ABC 7.5–2	0–7.5	0–2 amp	4¼″	8 5/32″	9⅝″	**$139.00**
ABC 15–1	0–15	0–1 amp	4¼″	8 5/32″	9⅝″	**$139.00**

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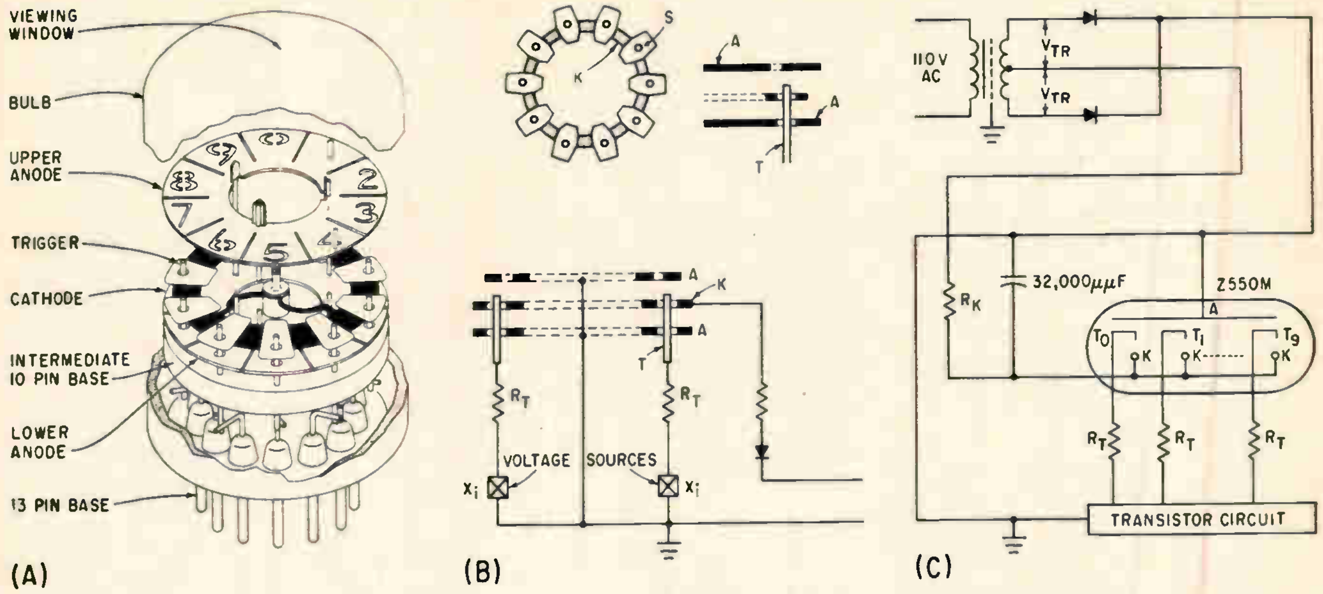
CIRCLE 57 ON READER SERVICE CARD



Unique geometry of Z550M (left) meets existing need for simple, easily read decade indicator capable of being actuated by low energy signal. Center diagram shows arrangement of cathodes and triggers (top) and circuit diagram of indicator tube (bottom). To control indication of a given number (right), the potential of the starter of that number should be raised by a minimum of 5 volts with respect to the remaining starters

Decade Indicator Operates Off Transistors

LESS THAN FIVE VOLTS SUFFICIENT TO PRODUCE GLOW INDICATION

UP TO NOW, it has been technically difficult and costly for transistor circuits to deliver signals that can ignite neon lamps or numerical indicators, and currents these circuits provide could not simply produce a clearly visible discharge without jeopardizing counting operations. Further, in the case of decade scalers, it would be more convenient to only one indicator tube for each decade.

These glow indication problems in transistorized decade counting are now handled with a new gas-discharge decade indicator tube, the Amperex Z550M, which responds to the small signals.

The new cold cathode tube is purely an indicator that requires less than five volts at less than 50 μA to produce the discharge. The red neon glow numerical count is viewed through the top.

The new indicator tube will be used in solid-state computers, scalers, and industrial counting devices. The tube operates directly off commonly used low voltage transistors, without intervening circuits or costly high voltage transistors.

Apart from giving a visual indictation, as in a mechanical register, scaler tubes form the primary functional elements of the circuit. This means that the resolution of the first decade, the critical one, is determined by the tube. Scaler tubes have been either gas-filled (ring-electrode scalers), or vacuum types (decade scaler tube E1T, as an example.) Resolution for the gas-filled type is about 300 μsec; and for the vacuum decade scaler E1T, the resolution is about 30 μsec. The gas-filled scaler is useful only where the highest counting rates are not required.

In counting circuits requiring exceptionally high resolution (0.1 to 1 μsec), functions of scaling and indication are separated. Scaling is performed by vacuum-tube circuits having resolution down to 0.1 μsec, with double triodes or decade selector tubes. Indication is provided by neon lamps or by numerical indicator tubes.

Transistor circuits are of course more compact, they have low energy consumption, and they achieve a resolving power almost as high as the best electron tube circuits. But up to the advent of the Z550M, a transistor circuit has presented difficulties for delivery of a reliable signal to work a glow lamp.

The extremely low triggering voltage and current of the new tube are due largely to the proprietary molybdenum sputtering technique used in the manufacture of the tube, and to the geometry of the electrodes. The sputtering technique is a method by which molybdenum is sprayed on the cathode and on a large area of the glass envelope. This technique improves cathode stability and helps maintain the purity of the neon-argon gas within the tube.

This electrode geometry of the tube is unique (see above). The cathode is ring-shaped and has ten evenly spaced holes into which the trigger electrodes are placed. Clearance between triggers and

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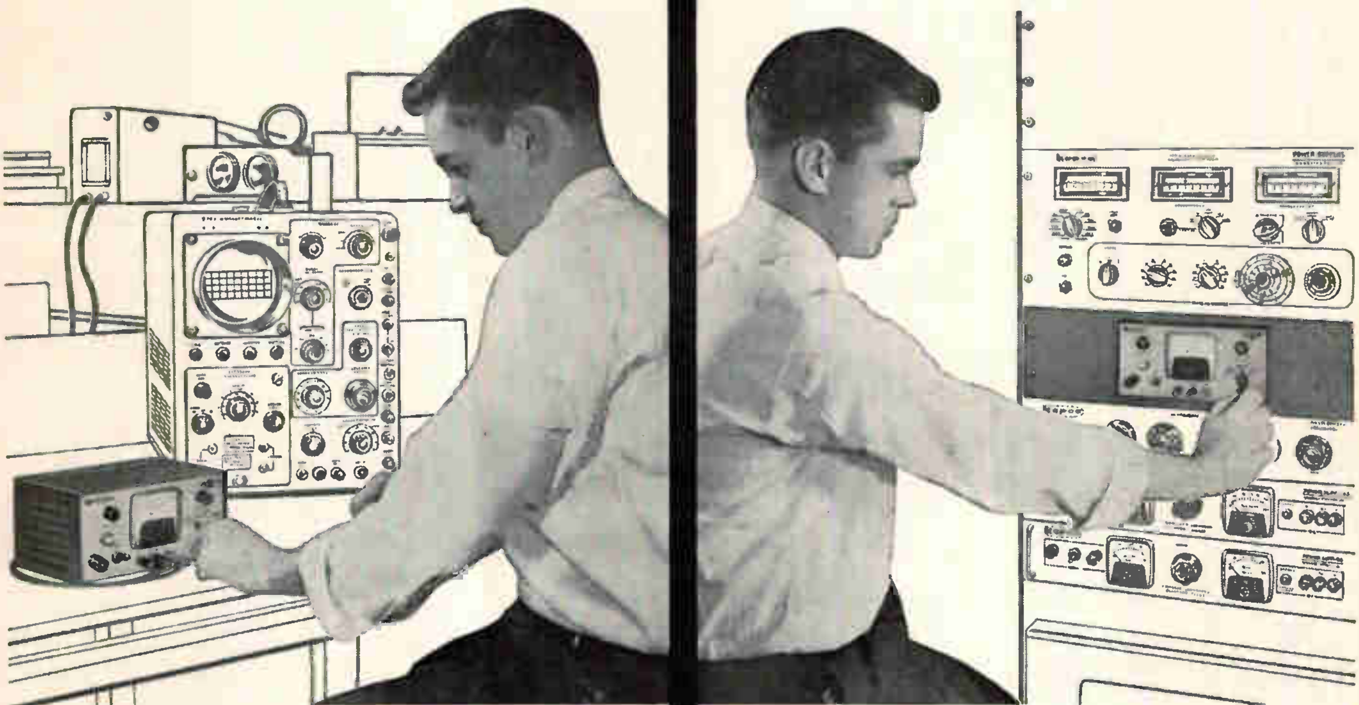

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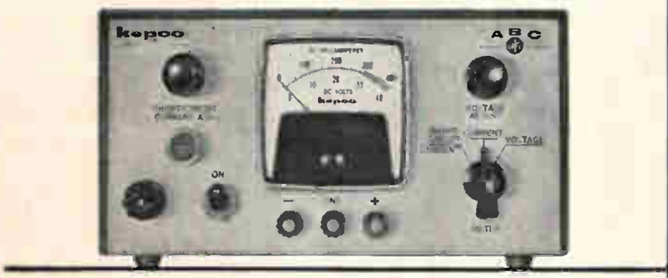

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For meter: Add suffix "M" to Model No. and $20.00 to price.
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TABLE I—TRANSMITTER PARAMETERS

Frequency in Mc	Pulse Width in μsec	Pulse Rate in PPS
1310	6	244
2982	1	400
425	125	27
425	250	27
425	500	27
425	1000	27
425	2000	27
8900	2.5	400

TABLE II—PERCEPTION THRESHOLD

Frequency in Mc	Power Density in mw/cm²		Peak Electric Field in v/cm²	Peak Magnetic Field in amp turns/m
	Average	Peak		
1310	0.4	267	14	4
2982	2.1	5250	63	17
425	1.0	263	15	4
425	1.9	271	14	4
425	3.2	229	13	3
425	7.1	254	14	4

in an anechoic chamber with no transducer sound.

An r-f threshold is given as 275 mw per sq cm determined in ambient noise of 80 db. Ear plugs attenuate ambient noise to 30 db. If 1 mw per sq cm is zero db, 275 mw per sq cm is 24 db. As noise level is reduced from 50 to zero db, r-f energy is reduced 50 db to −26 db or about 3 microwatts per sq cm. In an anechoic room, theoretically r-f sound would be induced by 3 microwatts per sq cm peak power density in free space.

Since only about 10 percent of this energy is likely to penetrate the skull, the auditory system and a radio may be an order of magnitude apart in r-f sensitivity.

The detection mechanism apparently is not an effect in which the tympanic membrane and oval window act as capacitor plates. Loudness of r-f sound is not changed appreciably by changing the subjects position in the r-f field, while there is a marked change in the effect on a capacitor. Also spacing between the membranes is small compared to the wavelength used and a subject was found with osteosclerosis who hears the r-f sound.

The cochlea is not ruled out as

the site of the detection mechanism. Another likely place is the cerebral cortex. Evidence exists of an electrostatic[4] and a magnetic[5] field about the neurons. Also R. Becker reported to the author of the conference paper evidence of longitudinal flow of charge carriers in neurons. Thus an electromagnetic field might well interact with the neurons. Frey also learned of experiments by F. Hiltz which suggest that synapses may act as diodes.

The most sensitive area was the temporal lobe. When all other areas of the head were shielded, the r-f sound was still heard.

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(3) R. Nieset, L. Pinneo, R. Baus, J. Fleming and R. McAfee, Annual Report, RADC TR-61-65.
(4) H. Burr and A. Mauro, Electrostatic Fields of the Sciatic Nerve in the Frog, *Yale J Biol Med*, 21, p 455, 1949.
(5) R. Morrow and J. Seipel, The Magnetic Field Accompanying Neural Activity; A New Method for the Study of the Neuron System, *J Wash Acad Sci*, p 1, 1960.

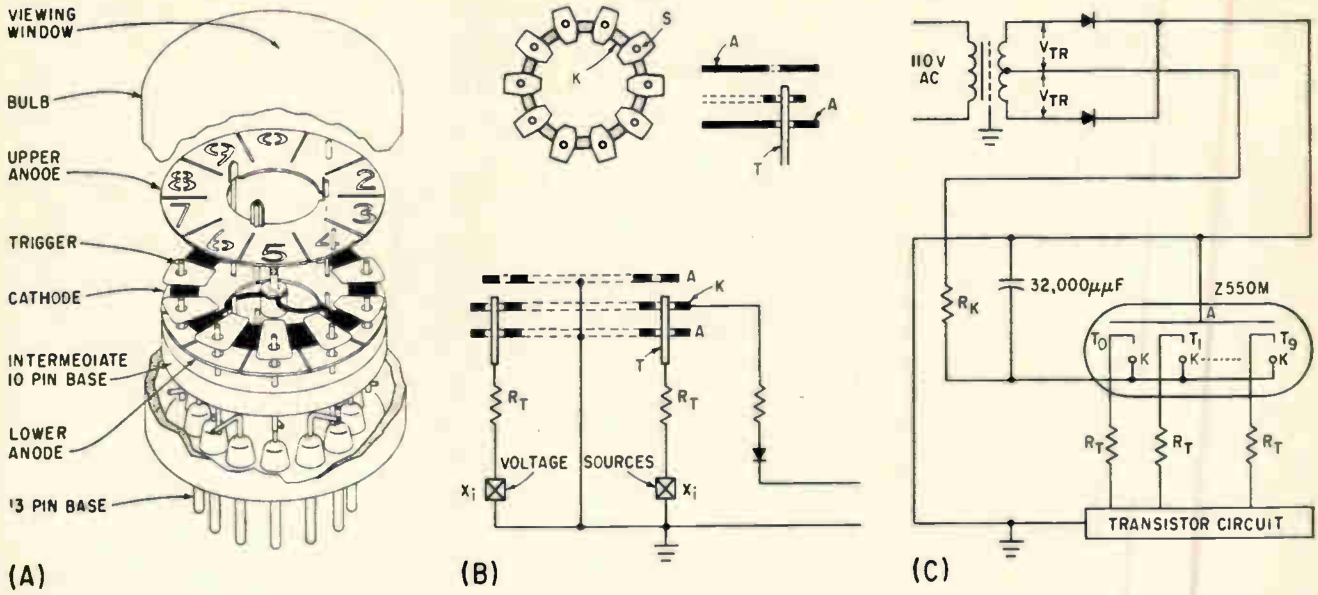
Photoelectric Encoder For Untended Weather Station

PHOTOELECTRIC setting device converts barometric pressure indications into digital form. It will be used at an unattended nuclear weather station from which information will be transmitted on a year-round basis.

The station was developed for the Atomic Energy Commission by the Nuclear Division of The Martin Company. The photoelectric encoding device was designed and developed by Kollsman Instrument Corp., a subsidiary of Standard Kollsman Industries. The weather station is scheduled for shipment in the near future to a remote location north of Canada. Weather data will be transmitted from the station up to 1,500 miles.

The photoelectric encoder has no contacts, slip rings or magnetic reaction. It has been mated to a standard Kollsman altimeter setting indicator by removing the altimeter pointer and gearing it directly to the encoder.

The instrument will transmit barometric pressure data in digital form twice during a 17-minute period at three-hour intervals.



Unique geometry of Z550M (left) meets existing need for simple, easily read decade indicator capable of being actuated by low energy signal. Center diagram shows arrangement of cathodes and triggers (top) and circuit diagram of indicator tube (bottom). To control indication of a given number (right), the potential of the starter of that number should be raised by a minimum of 5 volts with respect to the remaining starters

Decade Indicator Operates Off Transistors

LESS THAN FIVE VOLTS SUFFICIENT TO PRODUCE GLOW INDICATION

UP TO NOW, it has been technically difficult and costly for transistor circuits to deliver signals that can ignite neon lamps or numerical indicators, and currents these circuits provide could not simply produce a clearly visible discharge without jeopardizing counting operations. Further, in the case of decade scalers, it would be more convenient to only one indicator tube for each decade.

These glow indication problems in transistorized decade counting are now handled with a new gas-discharge decade indicator tube, the Amperex Z550M, which responds to the small signals.

The new cold cathode tube is purely an indicator that requires less than five volts at less than 50 μA to produce the discharge. The red neon glow numerical count is viewed through the top.

The new indicator tube will be used in solid-state computers, scalers, and industrial counting devices. The tube operates directly off commonly used low voltage transistors, without intervening circuits or costly high voltage transistors.

Apart from giving a visual indictation, as in a mechanical register, scaler tubes form the primary functional elements of the circuit. This means that the resolution of the first decade, the critical one, is determined by the tube. Scaler tubes have been either gas-filled (ring-electrode scalers), or vacuum types (decade scaler tube E1T, as an example.) Resolution for the gas-filled type is about 300 μsec; and for the vacuum decade scaler E1T, the resolution is about 30 μsec. The gas-filled scaler is useful only where the highest counting rates are not required.

In counting circuits requiring exceptionally high resolution (0.1 to 1 μsec), functions of scaling and indication are separated. Scaling is performed by vacuum-tube circuits having resolution down to 0.1 μsec, with double triodes or decade selector tubes. Indication is provided by neon lamps or by numerical indicator tubes.

Transistor circuits are of course more compact, they have low energy consumption, and they achieve a resolving power almost as high as the best electron tube circuits. But up to the advent of the Z550M, a transistor circuit has presented difficulties for delivery of a reliable signal to work a glow lamp.

The extremely low triggering voltage and current of the new tube are due largely to the proprietary molybdenum sputtering technique used in the manufacture of the tube, and to the geometry of the electrodes. The sputtering technique is a method by which molybdenum is sprayed on the cathode and on a large area of the glass envelope. This technique improves cathode stability and helps maintain the purity of the neon-argon gas within the tube.

This electrode geometry of the tube is unique (see above). The cathode is ring-shaped and has ten evenly spaced holes into which the trigger electrodes are placed. Clearance between triggers and

cathode sectors is about 0.3 mm. Because of this very small gap, a correspondingly low voltage can initiate the discharge.

Being a cold cathode, the tube requires no heating power or warm-up time. The tube is inherently a long life device, designed for over 30,000 hours of operation.

Coated Molydbenum Ring

Diagrams show the arrangement of cathodes and triggers. The face of a molydbenum ring, *K*, is coated with ten sectors of a material with a higher work function (shaded in diagram). The ten sectors, *S*, in between them each act as a cathode. About 3 mm above and below this ring, two other rings are mounted, acting as anodes. The upper anodes are provided with cutout figures 0 to 9 that can be read by the glow behind them. Through a hole in each of the ten cathode sectors, a wire electrode, *T*, the trigger, initiates discharge at the desired place. The clearance between the triggers and the cathode sectors is about 3 mm.

The tube is filled with neon gas, to which a small percentage of argon has been added. This choice of gas filling helps keep down the relative difference in breakdown voltage between the various trigger-cathode spaces. The gas pressure is about 10 cm Hg. To obtain a clean cathode surface, the cathode is sputtered during manufacture. The sputtered material on the glass wall helps to keep the gas uncontaminated.

The tube is fed with a rectified alternating voltage, which is not smoothed. A discharge is initiated when the amplitude of this voltage is sufficiently high. For a half-wave rectified supply, the supply voltage rises to a maximum and drops to zero once in every power supply cycle. The tube is therefore ignited and extinguished once per cycle. However, a full wave rectified voltage may also be used.

As seen in the circuit diagram of the tube, the triggers are at the same potential as the anode, so long as there is no discharge. A discharge between the cathode and one of the triggers has a lower ignition potenial than a discharge between cathode and anode. Therefore, when the voltage begins to rise from zero, a discharge first occurs between the cathode and one of the triggers. If the current produced by this auxiliary discharge is high enough, the anode takes over the discharge almost immediately. The potential difference between cathode an anode then drops to the burning potential of the main discharge now occuring between these electrodes (a glow discharge), so that for the rest of that particular half cycle none of the other triggers can reach their breakdown potential.

The place where the auxiliary discharge occurs can be selected by making the potential of the relevant trigger higher than that of the other triggers (and of the anode) by a small amount X. As a result, this trigger reaches the breakdown potential earlier than the others and the discharge always recurs at the same position. If the voltage X is transferred to another trigger, the reignition in the next power supply cycle will take place at that trigger, and so on.

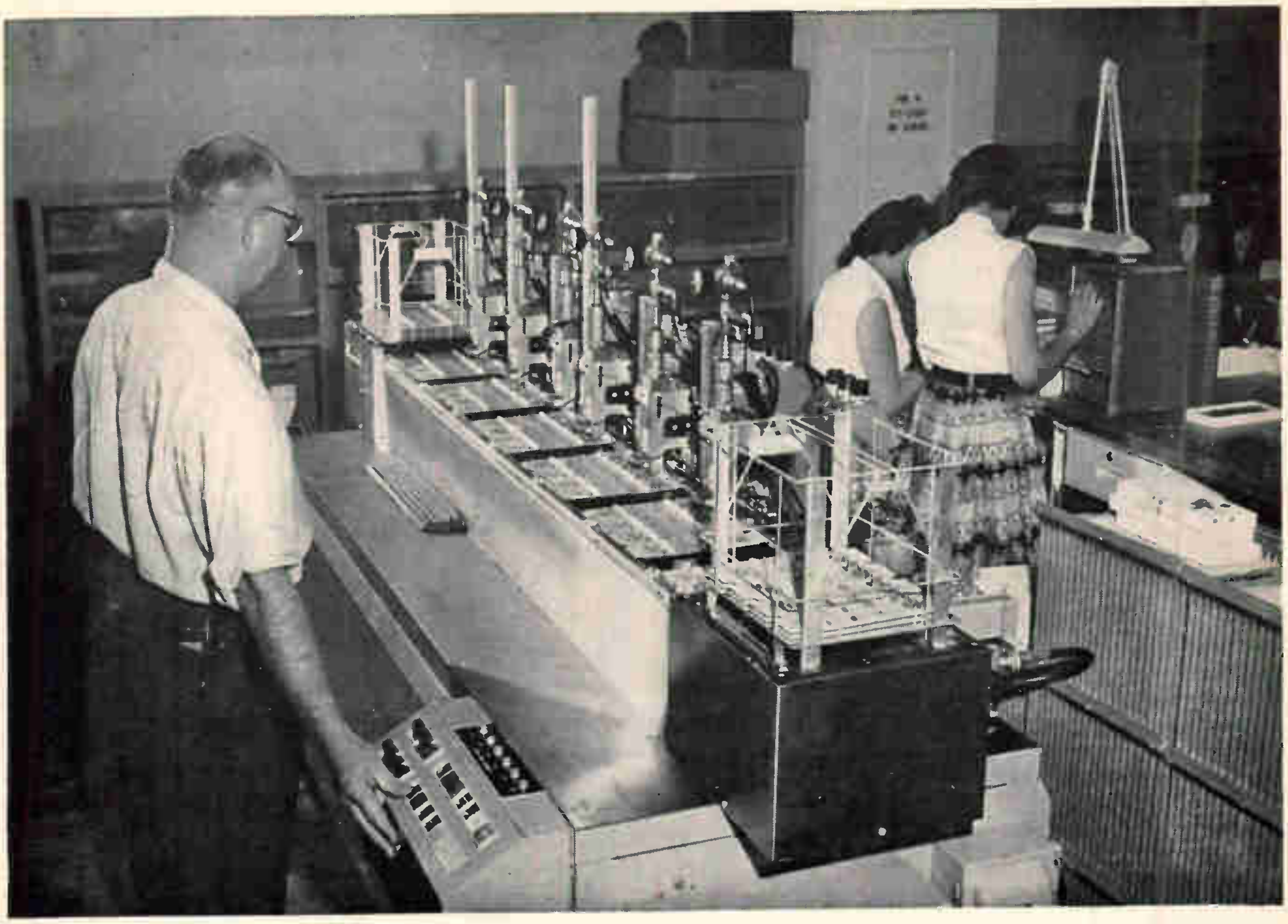
Signal Drive for the Tube

The periodic extinction of the discharge is thus essential to be able to displace the discharge from one position to another. It follows that the tube can be driven with a signal whose amplitude (always less than 5 v) is much smaller than the breakdown voltage itself.

This small signal can be supplied by a transistor circuit. If the signal is so designed that a signal X is applied to the trigger T_1 for a count of 1, to the adjacent trigger T_2 for a count of 2, and so on, one can read from the tube the total result of the count.

It is immaterial whether or not the tube can follow a rapid counting operation because upon the next reignition after the completion of the counting operation, the tube always glows at a position corresponding to the final result of the count. Since the power for the main discharge is not drown from the transistor circuit, this discharge is bright enough to provide a clear visula indication.

Anode in the circuit is grounded. This makes it possible to ground one of the two terminals of the voltage sources that supply the control signal. In practical applications, these sources are part of the transistor circuit.



Insertion machine has six stations for inserting TO-5 size transistors, can achieve insertion rates of 6,000 transistors per hour. Boards of eight circuit cards are loaded and unloaded manually

Special Machines Insert Transistors in Cards

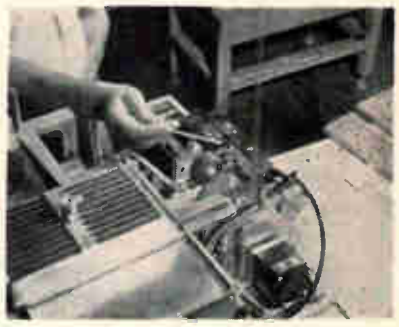
By PAUL J. ADAMIK,
International Business Machines Corp., Endicott, N. Y.

IN PRODUCING printed circuit cards, the one step that has longest defied machinization is the preparation and insertion of transistors. It was not until almost all other steps had passed through at least one phase of mechanization that the first transistor handling machines were approved for the production line.

Recently installed by IBM on the production line at Endicott, N. Y. are three machines: one loads transistors into extruded plastic magazines; another trims and straightens leads; the third inserts transistors into cards. The machines are designed to handle only the TO-5 package at this time.

Loading is handled on a small table and feeding device which orients the transistors and loads them in a plastic magazine. Transistors are hand-fed into a device which holds the transistors in rows on a table. A belt carries the transistors along; underneath it is a second belt with small magnets that hold the transistors in place on the top belt.

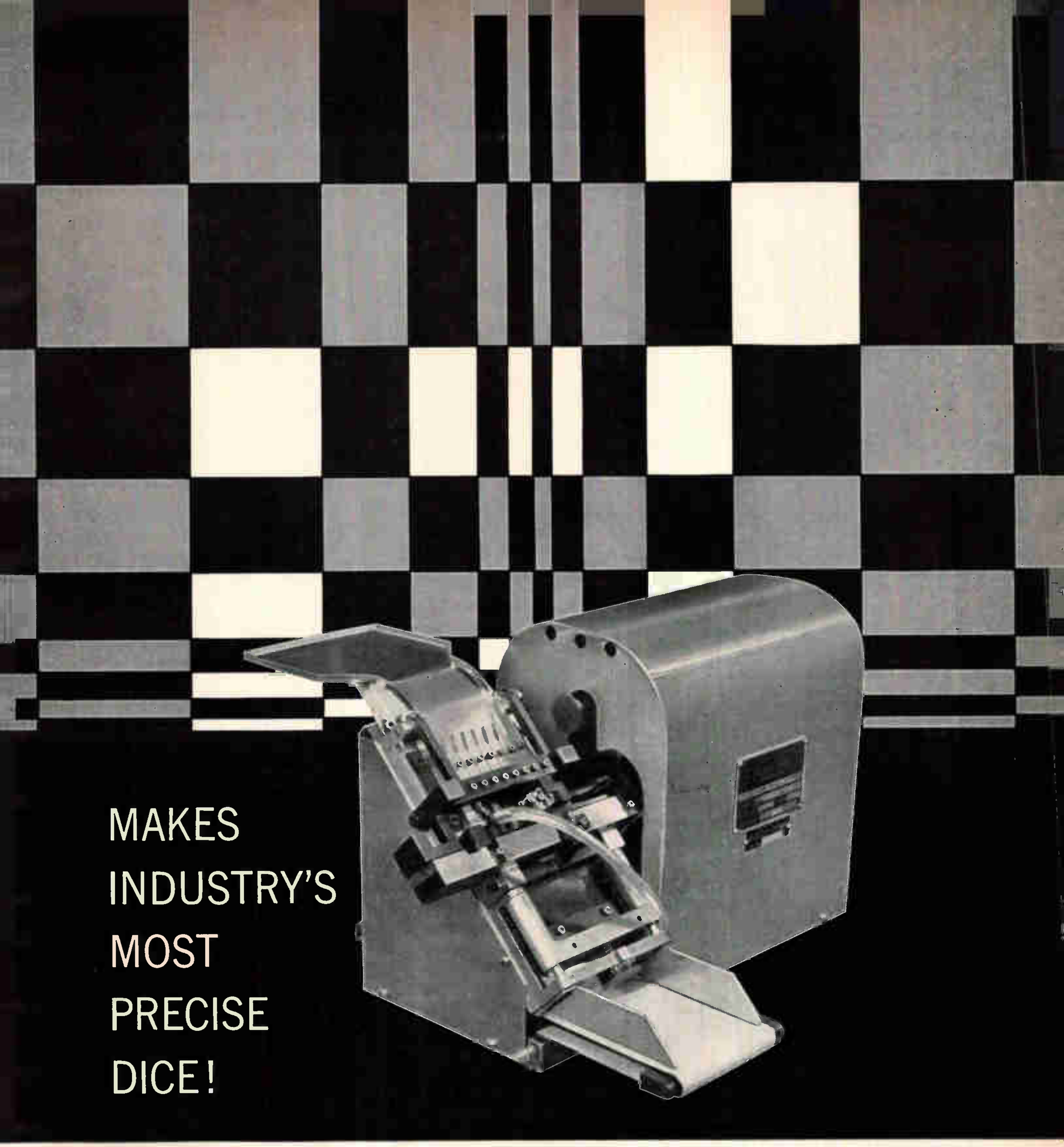
At belt's end, a draft of air forces the transistors around a corner in the passage, and two sets of teeth engage the leads and orient the transistor. The transistor leads, two of which are on the transistor center line, are thereafter held in orientation by a lip protruding over the transistor passage way. The passage then bends toward the floor and transistors enter plastic magazines.



Transistors, loaded by hand in rows, are carried by belts past the toothed orientation station, then are loaded in special plastic magazines that preserve lead orientation

Loaded magazines are then pro-

CIRCLE 65 ON READER SERVICE CARD→



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cessed in a transistor preparation machine, which straightens the leads, cuts them to length, and puts them back in similar plastic magazines, with the same orientation.

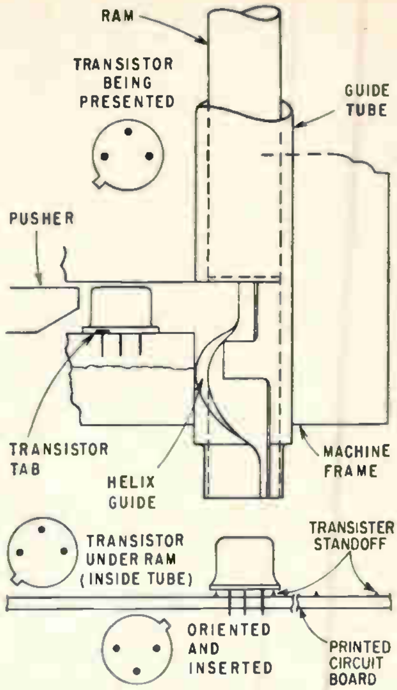
As shown in one of the photographs, the machine uses two drums, with each holding 12 magazines.

The top drum indexes each magazine in turn to the operation chute, where the transistors feed down by gravity. First, the leads are cut to ½ inch; at the next station a combing action removes sharp bends and kinks from the leads; at the last station the leads are straightened again, positioned, and cut to 0.156 inch. The bottom drum collects the transistors. The preparation machine processes an average of 150 transistors a minute.

The transistor insertion machine handles only a six-transistor card—a high volume item. Boards, consisting of eight cards, travel from the feed hopper along transfer tracks by pneumatically-operated feed pawls. Travel along the transfer tracks is in 30 progressions of 2.6 inch each, with the board passing under six insertion stations.

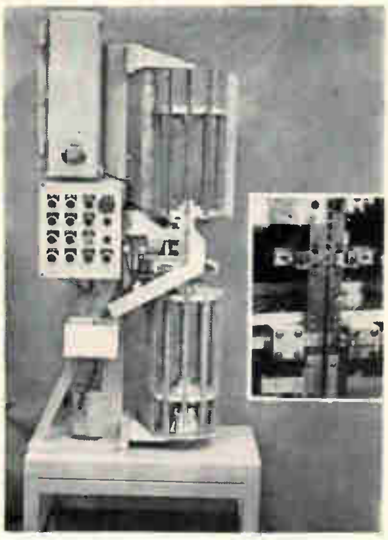
Each insertion station is individually controlled, so that the transistors are inserted only in those card positions which require them.

Transistors gravity-feed from the magazine to a leads-down position just below and to one side of a ram. A small pusher finger then pushes the still oriented transistor under the ram where it is held by a permanent magnet embeded in the ram. The ram descends, pushing the transistor through a helix tube. The helix engages the transistor tab, rotating the transistor so the leads fit precisely into prepunched holes in the card below.



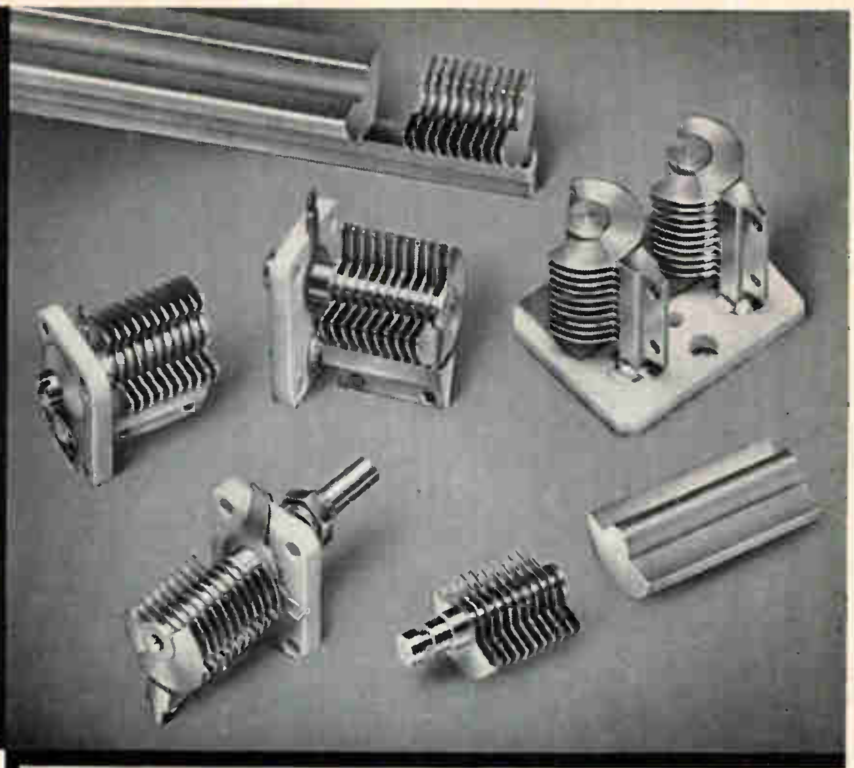
Transistors are pushed into place below the ram, then the outside tube descends to serve as a guide. The ram then pushes the transistor down, with the tab traveling along a helix to position the transistor for insertion

The driven ram is opposed by a mechanical spring, with a maximum net force on the transistor of five pounds, a force insufficient to bend the lead wires if leads and holes do not match. A crimping device under the card attaches the transistor; an interlock will shut down the machine when necessary. A programmable or variable helix would give the inserter added flexibility but was not necessary for the first design. Each inserter has a capacity of two magazines. Transistors are accepted from one magazine until it is empty, then the positions of the two magazines are interchanged. When this interchange takes place, an amber light warns the operator. The insertion machine will function automatically as long as supplies of transistors and boards are maintained and the completed boards are removed. The pneumatically operated machine can achieve rates of up to 6,000 insertions per hour.



Lead straightening and cutting machine uses indexing drums, gravity feed, manual loading and unloading. Inset shows detail of one of the lead straightening combs

Designed for *Application*



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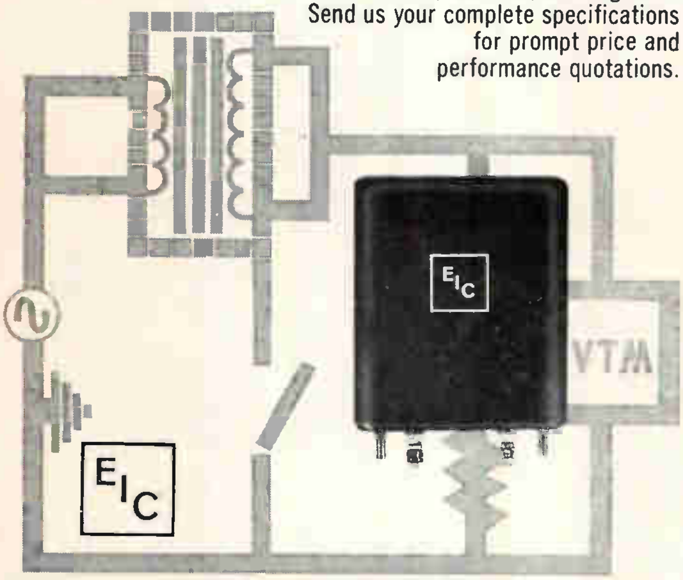

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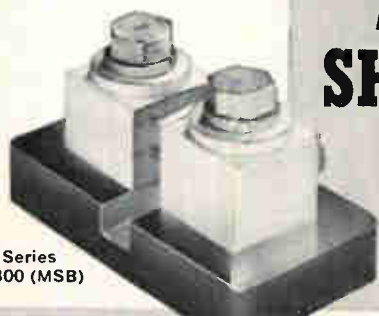

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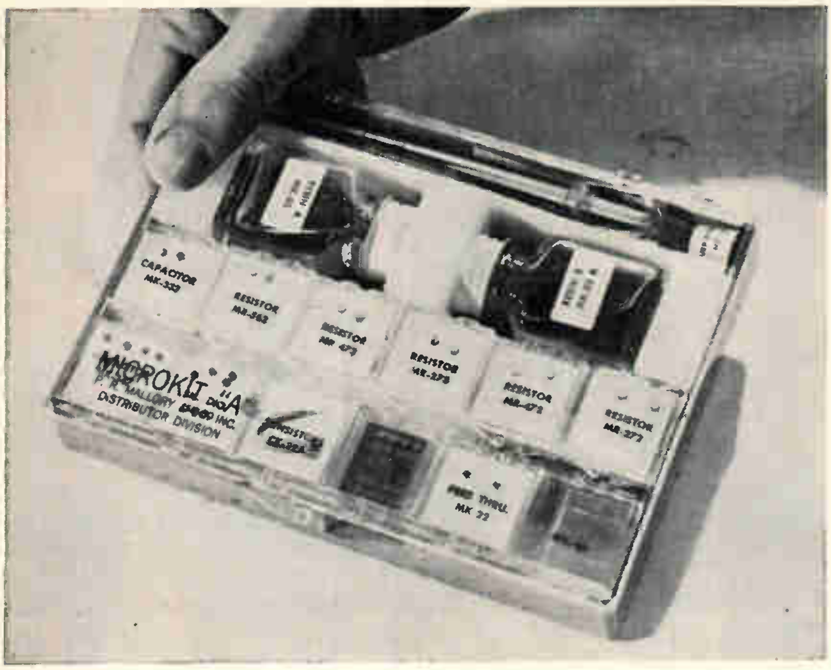
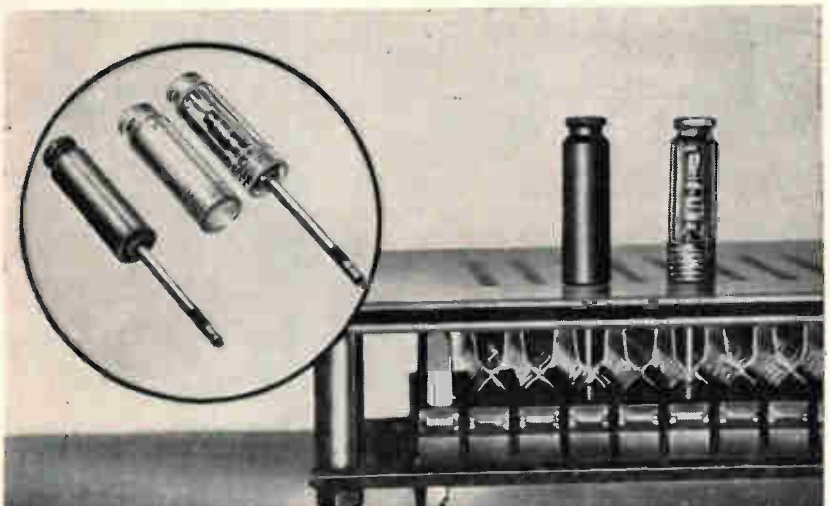
New On The Market



Experimental Kits
FOR ASSEMBLING MICROCIRCUITS

P. R. MALLORY & CO. INC., Indianapolis 6, Ind., introduces kits that enable design engineers to experiment with techniques for shrinking new electronic systems. The "A" kit, priced at \$44.95, contains all microcomponents required to build a complete 22-component 10 Kc flip-flop having set and reset capabilities. Complete circuit occupies 0.179 cu in. The "B" kit, containing additional materials for assorted circuits, is priced at \$139.95. Both kits are based on the pellet component configuration. Circuit elements in cylindrical form fit into holes in printed wiring boards.

CIRCLE 301 ON READER SERVICE CARD



Plastic Diode Holders
VISUAL COMPONENT IDENTIFICATION

SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N.Y. Clear plastic holders permit identification of color codes or type markings of diodes and other components. They are useful in determining polarity of subminiature diodes when more than one assembly polarity is necessary such as in building bridge circuits, or obtaining desired digital logic patterns. The holders allow programming personnel to clearly see the component that is soldered in the holder, and thus select the desired type for insertion in the Sealectoboard matrix.

CIRCLE 302 ON READER SERVICE CARD

Voltage Detector
ALL SOLID STATE

HALMAR ELECTRONIC PRODUCTS CO., LTD., 1550 R West Mound St., Columbus 23, O. All solid state, portable transient detection and measurement instrument, model EB-1, has three ranges of 100 v, 1 Kv, 10 Kv. Direct reading dial and built in self-calibration and test features eliminate need for calibration reference charts. Accuracy to ±1 percent for transients to 1 μsec rise-time, down to d-c. Relay output and automatic reset allows external control, indication and recording on repetitive transient events.

CIRCLE 303 ON READER SERVICE CARD

Ga As Switching Diode
NSEC RECOVERY TIME

DIOTRON INC., 3650 Richmond St., Philadelphia 34, Pa. The Nanoswitch is a gallium arsenide ultra-fast switching diode with nano-

second recovery time that can be operated at temperatures up to 300 C. Maximum inverse current is 1.0 μa at 25 C and 10μa at 300 C.

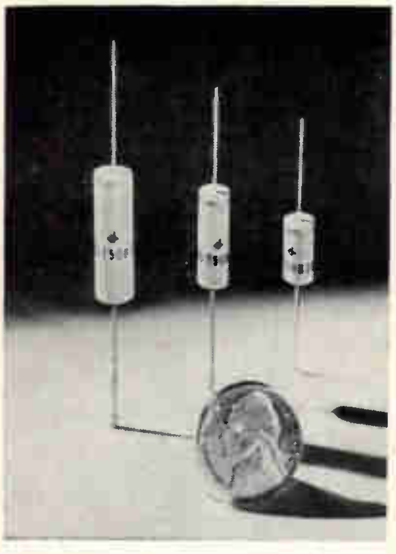
Maximum forward voltage is 0.6 v and peak pulse current is 300 ma.

CIRCLE 304 ON READER SERVICE CARD

Circular Waveguide Feed
USED ON 6 TO 8 GC

MARK PRODUCTS CO., 5439 West Fargo, Skokie, Ill. The circular waveguide feed, employing a rectangular to circular waveguide transition section 8 in. long, allows a man to adjust polarization a full 360 deg in the field simply by rotating the transition section. The circular feed is used on 6 to 8 Gc, 4, 6, 8, and 10 ft parabolas. A dual polarized adapter is available for converting a single polarized feed simply by replacing the transition section.

CIRCLE 305 ON READER SERVICE CARD



Zener Reference Diodes
HIGH VOLTAGE

DICKSON ELECTRONICS CORP., 248 Wells Fargo Ave., Scottsdale, Ariz. Consisting of 26 preferred voltages ranging from 18.5 to 200 v, these Zener reference diodes feature temperature coefficients of 0.005 percent per deg C max with a ± 5 percent max tolerance on nominal Zener voltage. Units have temperature ranges of 0 to +75 C and −55 C to +100 C. They were designed to meet the mechanical and environmental requirements of MIL-S-19500B.

CIRCLE 306 ON READER SERVICE CARD

Sprayed-on Heaters
GIVE RELIABILITY

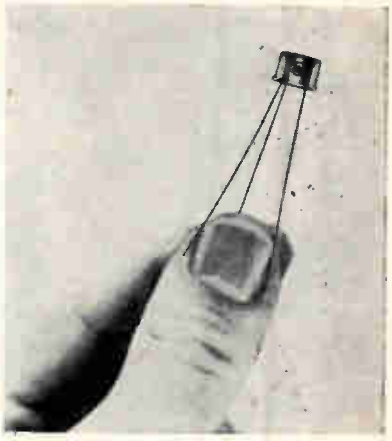
ELECTROFILM, INC., 7116 N. Laurel Canyon Blvd., N. Hollywood, Calif. Custom sprayed-on heating elements give reliability to temperature sensitive components. The heater element on the transistor oven, as pictured, has an internal temperature control that maintains environment at 92 C ± 1 C with watt density sufficient to provide initial temperature rise from as low as −45 C to +92 C in less than 15 minutes. The conductive and insulating coatings combined of sprayed-on heaters are only 0.15 in. thick.

CIRCLE 307 ON READER SERVICE CARD

Coax Hybrid Rings

MICROLAB, 570 W. Mt. Pleasant Ave., Livingston, N. J. Series of coaxial hybrid rings consists of a coax line in the shape of a circle of 1½ wavelengths circumference with four branch arms.

CIRCLE 308 ON READER SERVICE CARD



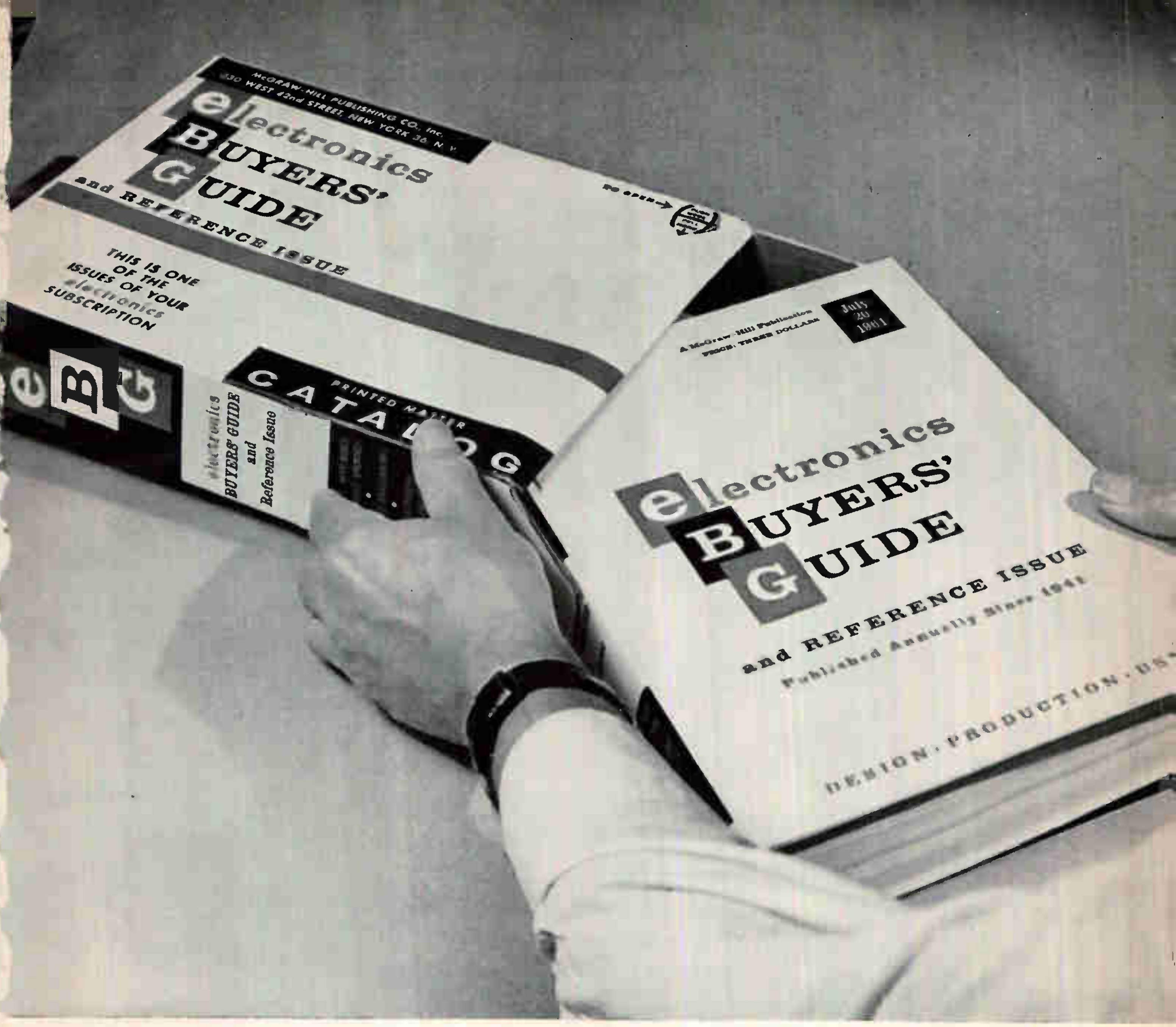
Composite Transistor
ULTRAHIGH BETA

SOLID STATE ELECTRONICS CO., 15321 Rayen St., Sepulveda, Calif. Model SST 610 is a three terminal device containing a matched pair of hermetically sealed *npn* diffused mesa silicon transistors in a composite configuration. Features: Current gain exceeds 5,000; current range from 1 ma to 500 ma; dissipation 1 w at 25 C case temperature; low saturation voltage at high collector current; temperature range from −55 C to +150 C.

CIRCLE 309 ON READER SERVICE CARD

Waveguide Switch

MICROWAVE ASSOCIATES, INC., Burlington, Mass. The MA-3470 2X1 is



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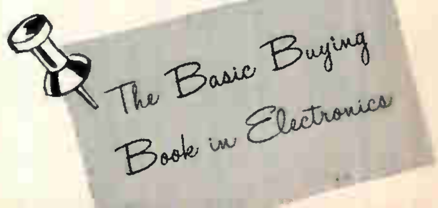
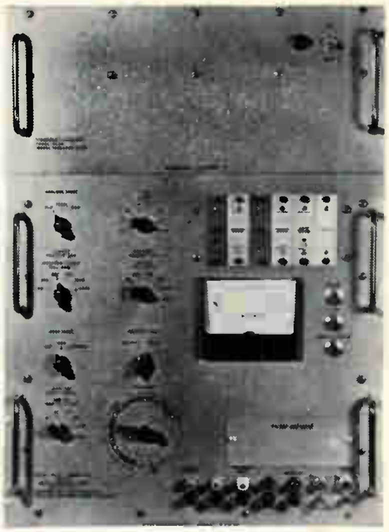


a rugged, compact unit for applications in which ultrafast switching combined with small size, light weight, and all-solid-state reliability is desired.

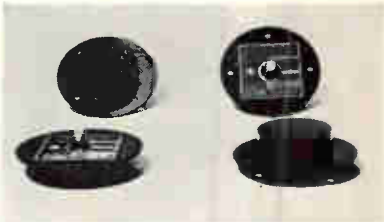
CIRCLE 310 ON READER SERVICE CARD



Probability Analyzer
USES LOGIC CIRCUITRY

SIERRA RESEARCH CORP., 240 Cayuga Rd., Buffalo 25, N.Y. The PA 101 probability analyzer consists of an operational amplifier for signal conditioning, an analog to digital encoder, logic circuitry, level-occurrence counters and readout circuitry. The signal to be analyzed is passed through an appropriate filter and encoded in binary form. The peak to peak value of the signal is then extracted and encoded. Logic circuitry is used to determine whether peak to peak value falls between each of 16 pairs of thresholds.

CIRCLE 311 ON READER SERVICE CARD



Cavity Antenna
S-BAND

CANOGA ELECTRONICS CORP., 15330 Oxnard St., Van Nuys, Calif. Model ACST-1A airborne cavity antenna operates over the frequency range from 2.75 to 2.95 Gc and has a vswr of less than 1.65 at continuous temperatures of up to 250 F. Complete antenna weighs less than 8 oz. has an aperture of less than 3 in. and an efficiency of greater than 90 percent. Unit meets MIL-E-5272C.

CIRCLE 312 ON READER SERVICE CARD

Force Transducer
LOW HYSTERESIS

ALLEGANY INSTRUMENT CO., 1091 Wills Mountain, Cumberland, Md. Model 344LS is a highly precise universal force transducer featuring particular stress on low hysteresis and minimum linearity error. Designed for tension and/or compression service, it guarantees an output of 2 mv/v ± 0.10 percent and is available in ranges from 50 lb to 1,000,000 lb.

CIRCLE 313 ON READER SERVICE CARD

Silicon Solar Cells
GRIDDED DEVICES

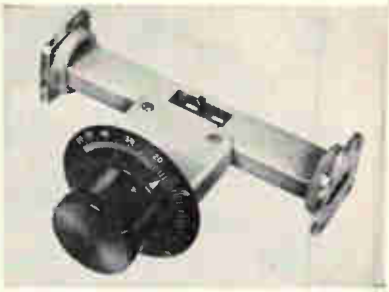
INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Silicon solar cells are available with conversion efficiencies as high as 13 percent due to a new collector strip process. Cells are now being manufactured with a number of secondary collector strips protruding from the main or primary strip, thus affording better collection of the current from the active area of the cell. Collectors form a grid network over the active cell area.

CIRCLE 314 ON READER SERVICE CARD

Voltage Comparator

ENGINEERED ELECTRONICS CO., 1441 E. Chestnut Ave., Santa Ana, Calif. Voltage comparator T-172 is a transistor circuit module that can detect d-c voltage levels in the range of −6 v d-c to + 6 v d-c.

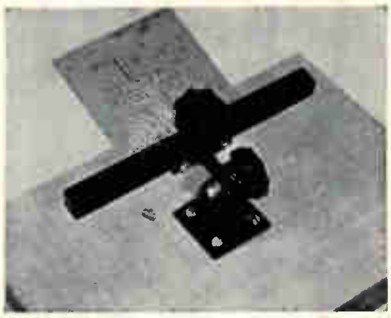
CIRCLE 315 ON READER SERVICE CARD



Variable Attenuator
DIRECT-READING

GENERAL MICROWAVE CORP., 47 Gazza Blvd., Farmingdale, N. Y. Type 170 panel-mounting attenuators, for military flight-line and ground-support equipment applications, are available in most waveguide sizes. They can alternately be furnished for operation over full waveguide bandwidth or with direct-reading calibrated dials for narrower-band use. Features include a drip-proof dial as a precaution against effects of rain and humidity and a metallized ceramic element.

CIRCLE 316 ON READER SERVICE CARD



Quick-Clip Vise
FOR P-C BOARDS

WESTERN ELECTRONIC PRODUCTS CO., 2420 North Lake Ave., Altadena, Calif. Vise provides a convenient method for holding p-c boards during assembly and hand-soldering operations. Simple, speedy clamping method cannot warp or crack boards. Jaws are designed to prevent solder creep onto etched contact fingers at ends of boards while hand soldering. P-c boards can be rotated in an arc in excess of 180 deg and are completely accessible on both sides. Price is $9.65 each.

CIRCLE 317 ON READER SERVICE CARD

PRODUCT BRIEFS

LIMITER AMPLIFIER dual channel. Dynatronics, Inc., P. O. Box 2566, Orlando, Fla. (318)

TRANSISTOR HEADER microminiature. Hermetic Seal Corp., 29-37 S. Sixth St., Newark 7, N. J. (319)

RECTIFIER TEST SET high accuracy. Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass. (320)

POLARIZER for p-c cards. The Ucinite Co., Newtonville, Mass. (321)

BLOCK TAPE READERS modular design. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. (322)

AUTOMATIC DICE SORTER cuts costs. Techni-Rite Electronics, Inc., 71 Centerville Rd., Warwick, R.I. (323)

POLYSTYRENE CAPACITORS miniaturized. Telephone Mfg. Co. Ltd., Martell Road, West Dulwich, London S.E. 21, England. (324)

FILAMENT MOUNTING MACHINE fully automatic. Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. (325)

THERMOCOUPLE SIGNAL CONDITIONER modular, eight-channel. Astra Technical Instrument Corp., Los Angeles, Calif. (326)

DIGITAL VOLTMETER modular construction. Franklin Electronics Inc., Bridegport, Pa. (327)

PARAMETRIC AMPLIFIERS single-knob tunable. Sylvania Electric Products Inc., P. O. Box 997, Mountain View, Calif. (328)

REMOTE CONTROL for variable autotransformers. General Radio Co., West Concord, Mass. (329)

MULTIPLIER PHOTOTUBE venetian-blind dynode structure. Radio Corp. of America, Harrison, N. J. (330)

SILICON POWER TRANSISTORS in TO-3 cases. Fanon Transistor Corp., 439 Frelinghuysen Ave., Newark 12, N. J. (331)

SOUND ANALYZER weighs 4 lb. Industrial Acoustics Co., 341 Jackson Ave., New York 54, N. Y. (332)

WELDED HAT RECTIFIER 1.6 amp half wave. Tucor, Inc., 59 Danbury Rd., Wilton, Conn. (333)

Literature of the Week

CARRIER SYSTEM Lenkurt Electric Co., Inc., San Carlos, Calif. Four-page brochure gives specifications of the type 46A transistorized multiplexing system. (334)

TELEMETERING CONTROL Daystrom, Inc., 4455 Miramar Road, LaJolla, Calif. Brochure describes the Telemetrol system, the digital solution for collection and control problems. (335)

DATA LOGGERS The Bristol Co., Waterbury 20, Conn. Bulletin D401 is written to alert potential users to the economy and application flexibility of Data-Master automatic data loggers. (336)

DYNAMIC LOAD Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. Model 705 dynamic load for testing power supplies is described in a recent catalog sheet. (337)

SOLID TANTALUM CAPACITORS Fansteel Metallurgical Corp., North Chicago, Ill. Two data sheets describe types STA polar and STAN non-polar high μf solid tantalum capacitors. (338)

MAGNET WIRE TESTING Hudson Wire Co., Winsted, Conn., has available a manual of test procedures for all film coated magnet wire types based on NEMA and MIL-W-583B specifications. (339)

CARDIAC SENTINEL Medtronic, Inc., Minneapolis 18, Minn., offers a bulletin describing the Sentinel, which instantly detects cardiac failure and automatically triggers ventricular systole. (340)

DATA RECORDING SYSTEM Westrex Co., 335 North Maple Dr., Beverly Hills, Calif. Brochure 3.11 covers a light-weight data recording system that records 14 tracks of data with laboratory precision in missile environments. (341)

FILLED RESIN Isochem Resins Co., 221 Oak St., Providence 9, R. I. Technical bulletin describes Isochemrez R9, a filled resin with a viscosity of 30,000 cps at 27 C. (342)

MICROWAVE COMPONENTS Microwave Components & Systems Corp., 1001 S. Mountain Ave., Monrovia, Calif. Catalog contains data on over 200 microwave components covering a range from 1.70 to 40.0 Gc. (343)

D-C AMPLIFIER Quan-Tech Laboratories, Inc., Boonton, N. J. Brochure describes model 205 fully transistorized, high stability d-c amplifier. (344)

DISPLAY SYSTEM Philbrick Researches, Inc., 127 Clarendon St., Boston 16, Mass. A 12-page booklet covers a multi-channel calibrated display system. (345)

P-C PRODUCTION London Chemical Co., Inc., 1533 No. 31st Ave., Melrose Park, Ill., has available a set of 4 flow charts for printed circuit production. (346)

TRANSFORMER COLOR CODES Stancor Electronics, Inc., 3501 Addison St., Chicago 18, Ill. A handy wall chart shows EIA color codes for transformers. (347)

VERSATILE FILTER Gelman Instrument Co., 106 N. Main St., Chelsea, Mich. A 24-page catalog describes advantages and applications of the Polypore membrane filter. (348)

SILVER PLATED COPPER WIRE Hudson Wire Co., Ossining, N. Y., announces a technical information bulletin on single end silver plated copper conductors. (349)

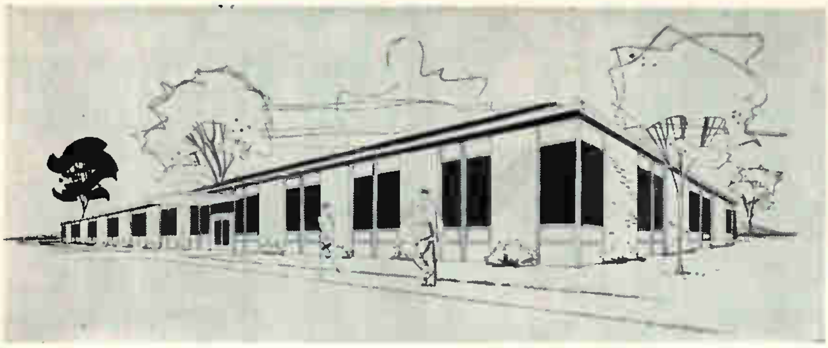
RELAYS Hillburn Electronics Corp., 55 Greenpoint Ave., Brooklyn 22, N. Y. A short-form catalog describes a wide variety of industrial and commercial relays. (350)

BRAZING ALLOYS Engelhard Industries, Inc., 75 Austin St., Newark 2, N. J. Reference chart details 37 Silvaloy compositions. (351)

SPECTRUM ANALYZER Federal Scientific Corp., 615 W. 131 St., New York 27, N.Y. Technical bulletin 611 covers the Simoramic high-speed fine resolution spectrum analyzer model 53. (352)

DIGITAL COMPUTER Digital Equipment Corp., 146 Main St., Maynard, Mass. Brochure F-11A illustrates and describes the PDP-1 programmed data processor. (353)

SOLID STATE PRODUCTS Modern Industries, Inc., 5755 Camille Ave., Culver City, Calif. Booklet describes facilities for the design and manufacture of solid state devices, components and equipment. Request on company letterhead.



Mallory Completing Research Lab

P. R. MALLORY & CO. INC. expects to occupy its 9,000 sq ft Laboratory for Physical Science this month. It is situated near Boston, Mass., in the vicinity of Route 128 and U. S. Highway 3. The facility supplements existing corporate laboratories in Indianapolis.

Donald G. Wilson, Mallory vice president for research and engineering, said that approximately 30 scientists and technical supporting personnel will staff the laboratory. A substantial portion of the group will consist of scientific personnel having advanced backgrounds in the fields of theoretical solid state, metallurgy and chemistry. Sumner P. Wolsky, director of the laboratory, is presently located in the Mallory office in Watertown, Mass.

Laboratory activity will be directed toward achieving a basic scientific understanding of material and electronic phenomena to support Mallory product development. Wilson said that the laboratory's responsibilities will include thin films, electrochemistry and molecular electronics. Facilities include a crystal laboratory designed to prepare epitaxial crystals for study of crystal growth behavior. A films laboratory will be used for the investigation of electrical, mechanical, optical, structural and magnetic properties of films.

Giannini Controls Appoints Van Utt

GIANNINI CONTROLS CORP. recently appointed Damon Van Utt general manager of its Connecticut-located Cramer Division. For the past three years he has served as vice president of engineering and manufacturing and director of operations for Cramer.

Transco Products Hires von Brimer

J. W. VON BRIMER has joined Transco Products, Inc., Los Angeles, as a research and development engineer, specializing in electronic transistor circuitry and rotating components.

Before coming to Transco, von Brimer worked as a consultant on rotating components and associated circuitry for such companies as Dal Motor, Delco Remy, Hydroaire and John Oster.

Goodrich Promotes Charles Stockman

CHARLES H. STOCKMAN has been named vice president and general manager of Goodrich-High Voltage Astronautics, Inc., Burlington, Mass. He formerly was manager, research operations, at The B. F. Goodrich Company's research center, Brecksville, O.

GHV Astronautics, a joint enterprise of the B. F. Goodrich Co., Akron, O., and High Voltage Engineering Corp., Burlington, Mass., is engaged in R&D and manufacture of ion propulsion motors for propelling vehicles in outer space, of power generation equipment for space vehicles, and of solid state electronic devices.

Molecular Dielectrics Adds Denton to Staff

MOLECULAR DIELECTRICS, INC., Clifton, N. J., has appointed Sterling C. Denton to its staff as metalizing and development specialist. He will direct all phases of the company's circuitry program and will utilize the circuitry laboratory recently added to the MD facilities.

Denton has specialized in printed circuit work for more than ten

years. His experience includes circuit design, engineering and production at Loral Electronics Corp. and Eastern Design Co.

Kaiser Appoints Wittmeyer

MERLE H. WITTMEYER has accepted a position as project engineer with the Phoenix electronics plant of Kaiser Aircraft & Electronics division of Kaiser Industries Corp.

Prior to this appointment, Wittmeyer was professor of nuclear engineering at the U. of Arizona in Tucson, Ariz.

BDSA Promotes Donald S. Parris

DONALD S. PARRIS, formerly director, Electronics Division, has been named to head the new Office of Industrial Equipment of the Business and Defense Services Administration, U. S. Department of Commerce.

Kollsman Instrument Hires Berthiaume

ORRIN BERTHIAUME has been named general manager of the Kollsman Instrument Corporation's Elmhurst, N. Y., plant. He will be responsible for instrument, optical and pitot tube manufacturing, and related support function.

Berthiaume comes to Kollsman from the Cannon Electric Co., Los Angeles, Calif., where he was production manager.

Shepherd Names Somerville V-P

ROGER L. SOMERVILLE, formerly director of research for Federal Mfg., has been named to the new post of vice-president, engineering, at Shepherd Electronic Industries, Plainview, L. I., N. Y.

In his new post Somerville takes full charge of engineering and production of all Shepherd electronic products, among them a complete line of new epoxy-encapsulated circuit modules and circuit synthesizers, made by the firm's Instant Circuits division.

PEOPLE IN BRIEF

George Wertwijn, ex-Hoffman Electronics, to Fansteel Metallurgical Corp. as director of device development for the Rectifier-Capacitor div. **Gerald H. Herman** leaves Sperry Gyroscope to join Tucor, Inc., as manager of vacuum tube products. **Ernest L. Gerdts** advances at Volkert Stampings, Inc., to production and development engineer. Kearfott Microwave promotes **George Nalesnik** to asst. g-m. **Ernest L. Cox**, formerly with Radiation, Inc., has joined the engineering staff of Instrument Corp. of Florida. **James C. Hosken**, previously with Farrington Mfg. Co., appointed technical asst. to the g-m of LFE Electronics. **Stuart R. Hennies**, from Granger Associates to E-H Research Laboratories, Inc., as chief engineer. **William E. Hall** (Lt. General, USAF, Ret.) is named a board member of Madigan Electronic Corp. **James L. Kimball** moves up at Kin Tel div. Cohu Electronics, Inc., to asst. chief engineer. **Robert Shaw Green**, ex-RCA, appointed to technical staff of Auerbach Electronics Corp. **Harry T. Needham** leaves Blaw-Knox Co. to become g-m of the Kennedy Antenna div. of Electronic Specialty Co. **John P. Curtis**, formerly with Itek Laboratories, named vice president of Adams-Russell Co.

EMPLOYMENT OPPORTUNITIES

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

COMPANY	SEE PAGE	KEY #
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pennsylvania	84	1
INTERNATIONAL ELECTRIC CORP. Paramus, New Jersey	93*	2
JET PROPULSION LABORATORY California Institute of Technology Pasadena, California	95*	3
LABORATORY FOR ELECTRONICS Boston, Massachusetts	79*	4
LOCKHEED MISSILES & SPACE CO. A Group Div. of Lockheed Aircraft Corp. Sunnyvale, California	22, 23	5
McDONNELL St. Louis, Missouri	85	6
MITRE CORPORATION Bedford, Massachusetts	91*	7
NATIONAL CASH REGISTER CO. Dayton, Ohio	86	8
REMINGTON RAND UNIVAC Div. of Sperry Rand Corp. St. Paul, Minnesota	84*	9
SANDERS ASSOCIATES INC. Nashua, New Hampshire	84	10
UNION CARBIDE NUCLEAR CO. Oak Ridge, Tennessee	84	11

* These advertisements appeared in the 10/27/61 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS..

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

HOME TELEPHONE..

Education

PROFESSIONAL DEGREE(S)......................................

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

1131

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

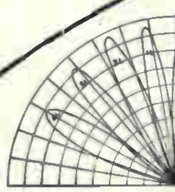
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

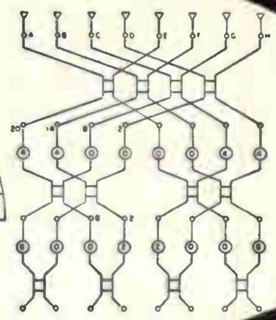
How Sanders

meets rising need for design simplification of sophisticated electronic equipments

New Beam-Forming Matrix for Electronic Scanning at Microwave Frequencies

This new Sanders development drastically reduces the astronomical number of components required by conventionally designed antennas. For instance, a 64 x 64 array requiring almost half a million 3-port dividers needs less than 25,000 hybrids with Sanders' new techniques. Accompanying diagrams illustrate radiation pattern and eight-element, eight beam matrix, formed by TRI-PLATE® components, a Sanders' first dating back to 1952.





Equally Challenging Assignments Open to Engineers at Sanders in Diverse Fields Such as:

Phased Array Radar
Pulse Doppler Radar Systems
Space and Communications Systems

Specific background required in

SYSTEMS DESIGN • TRANSISTOR CIRCUIT DESIGN
RECEIVER DESIGN • TRANSMITTER DESIGN

® reg. U. S. trademark

This phenomenal growth company—up from 11 men to over 2000 in 10 years—today has a backlog of over $90 million in diversified R&D and production contracts. Concentration on bold technical innovations rather than marginal improvements is the dynamic force behind this growth. If you believe your career will flourish in a creative atmosphere that favors the individual contributor, send a resume now to R. W. McCarthy.

All qualified applicants will be considered without regard to race, creed, color or national origin

SANDERS ASSOCIATES, INC.

(in the New Hampshire hills about an hour from downtown Boston) NASHUA, NEW HAMPSHIRE

Electronic Instrument Mechanics

The Oak Ridge National Laboratory
Operated by
Union Carbide Nuclear Company
at
Oak Ridge, Tennessee
Has openings for

Highly skilled electronic instrument mechanics to work with electronic engineers in the development, installation and maintenance of electronic systems. Digital data handling, transistorized pulse height analyzers, analog and digital computer systems are only a few examples. Minimum high school education, with additional training in electronics and at least three years' experience in installation and maintenance of complex electronic systems.

Excellent Working Conditions and Employee Benefit Plans

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Send detailed resume' to:
Central Employment Office
Union Carbide Nuclear Company
Post Office Box M
Oak Ridge, Tennessee

TRANSFORMER ENGINEER

With experience in the design and development of Hi-Frequency and Pulse transformers for commercial and military applications.

Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Pa. Call or send resume to Chief Engineer

Erie Electronics Division
Erie Resistor Corporation
645 West 12th Street Erie, Pa.
GL 6-8592

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES
EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, 2.40 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).

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR. 584 AUTOTRACK RADARS.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32GCA. AN/APS-10 NAVIG. & WEATHER.
AN/APS-15B PRECISION. AN/APQ-35B PRECISION.
AN/APS-31A SEARCH. DOZENS MORE.
.5-1-2 MEGAWATT HIGH POWER PULSERS.
MICROWAVE PLUMBING—TEST EQUIP.
LARGEST RADAR STOCK IN U.S.A.
RADIO RESEARCH INSTRUMENT CO.
550 Fifth Ave. New York Judson 6-4691

RADAR SYSTEMS & COMPONENTS / IMMEDIATE DELIVERY

CIRCLE 460 ON READER SERVICE CARD

LOOKING FOR USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of Oct. 13th

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Contact The McGraw-Hill Office Nearest You.

ATLANTA, 9—1375 Peachtree St. N.E.
TRinity 5-0523
D. HICKS

BOSTON, 16—Copley Square
COngress 2-1160
M. SHOUVLIN

CHICAGO, 11—645 No. Michigan Ave.
MOhawk 4-5800
W. J. HIGGENS - W. SONZSKI

CLEVELAND, 13—1164 Illuminating Bldg.
SUperior 1-7000

DALLAS, 2—1712 Commerce St.
Vaughn Bldg., RIverside 7-9721
J. GRANT

DENVER, 2—1700 Broadway—Tower Bldg.
ALpine 5-2981
J. PATTEN

DETROIT, 26—856 Penobscot Bldg.
WOodward 2-1793
WM. H. GINDER, JR.

HOUSTON, 25—Prudential Bldg., Room W-724
Holcombe Bldg., JA 6-1281
GENE HOLLAND

LOS ANGELES, 17—1125 W. 6th St.
HUntley 2-5450
W. C. GRIES

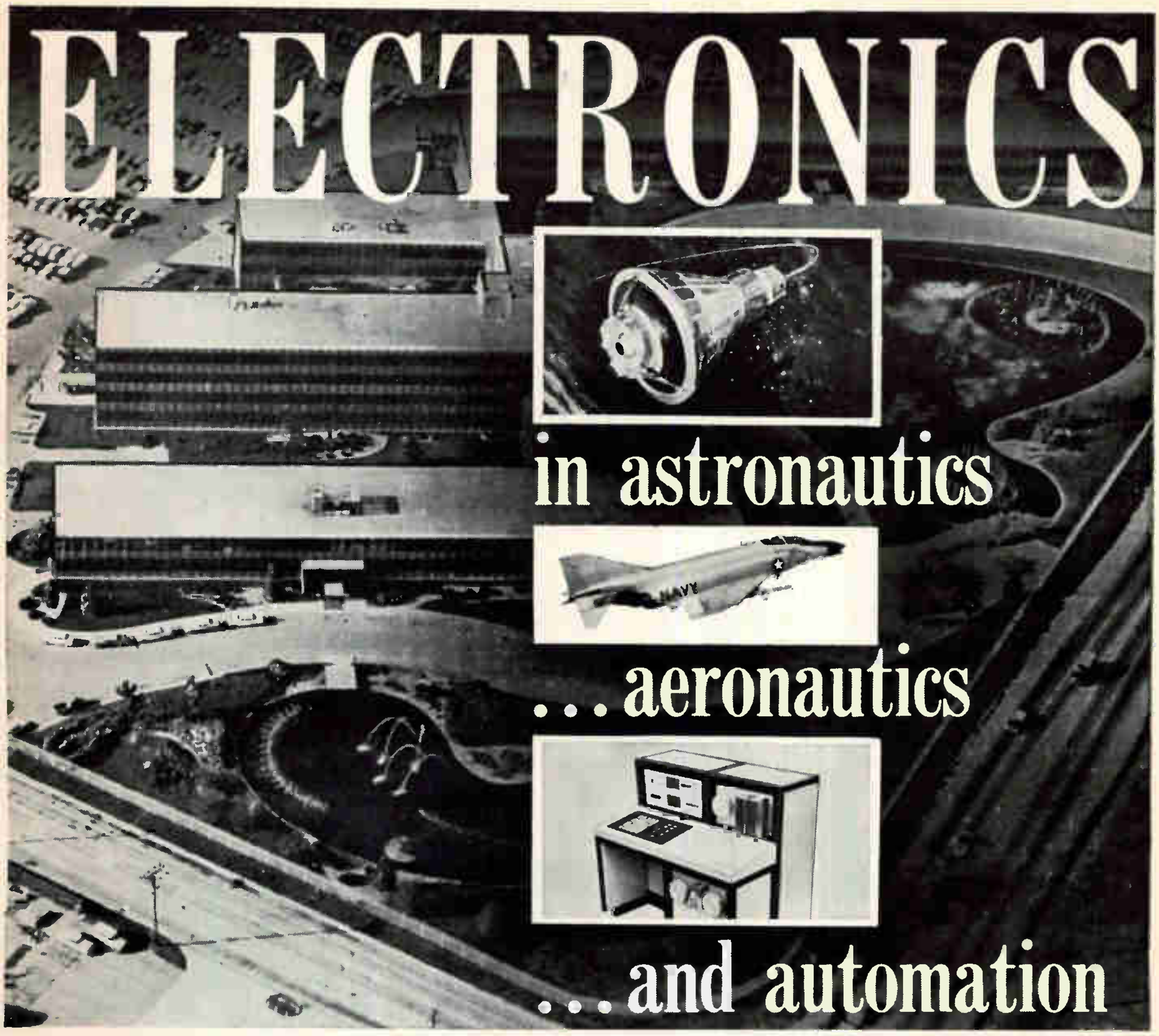
NEW YORK, 36—500 Fifth Ave.
OXford 5-5959
H. T. BUCHANAN - R. P. LAWLESS
T. W. BENDER - P. BOND

PHILADELPHIA, 3—Six Penn Center Plaza
LOcust 8-4330
W. B. SULLIVAN

PITTSBURGH, 22—4 Gateway Center
EXpress 1-1314

ST. LOUIS, 8—3615 Olive St., JEfferson 5-4867
R. BOWMAN

SAN FRANCISCO, 11—255 California St.
DOuglas 2-4600
J. A. HARTLEY



McDonnell achievements in aeronautics, astronautics and automation are often directly related to swift-paced developments in electronics. Wherever McDonnell requirements cannot be met by standard electronics systems, special equipment is designed and developed by McDonnell's own electronic engineers. These consistently demanding objectives have fashioned an electronics division geared to the design of highly specialized systems and components – products which often prove to be broad-scope advancements with many applications. McDonnell Electronics is now being expanded, and desirable openings exist for *electronic engineers* who are qualified to provide leadership in areas of systems and equipment development.

Advanced degree in E.E., M.E. or Physics required (experience at the supervisory level is desirable in at least one of the following areas:)

COMMUNICATIONS ● DIGITAL TECHNIQUES ● AUTOMATIC TEST EQUIPMENT ● MILITARY AIRBORNE & SOLID STATE ELECTRONICS ● ELECTROMAGNETIC FIELD THEORY ● MASER AND LASER THEORIES ● MICROWAVE TECHNIQUES ● RADIATION AND ABSORPTION PHENOMENA ● ELECTRODYNAMICS

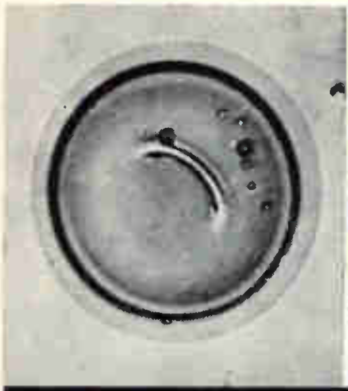
For full details, please submit your resume in complete confidence to:
MR. R. F. KALETTA, PROFESSIONAL PLACEMENT, DEPT. E,

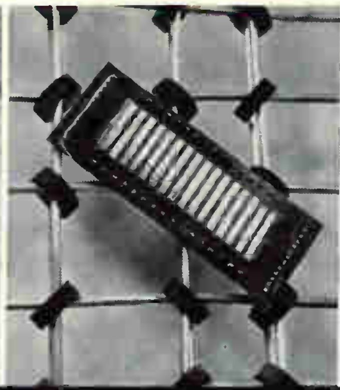
MCDONNELL

P.O. Box 516, St. Louis 66, Missouri

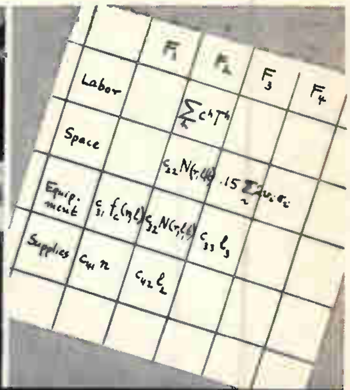
ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR OR NATIONAL ORIGIN.

NCR Research


MICRO-ENCAPSULATION


MAGNETICS


THIN FILMS



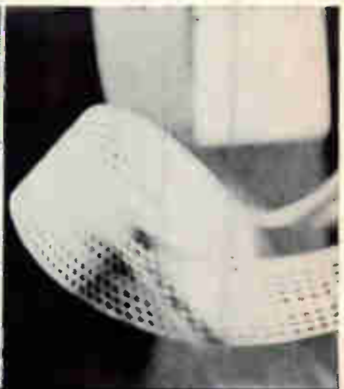
OPERATIONS RESEARCH

and Development


OPTICS


LOGIC & CIRCUITRY

MECHANICS


DIGITAL SYSTEMS

The National Cash Register Company presents above-average opportunity for the experienced scientist or engineer to apply his talents in a stable organization. Whether your interest lies in commercially oriented projects or advanced military electronic development, you will find lasting satisfaction and encouragement for professional advancement.

If your interests lie in one of the many fields of endeavor being carried on by The National Cash Register Company, you are invited to submit your resumé to us for consideration for one of the fine opportunities now open in Dayton, Ohio at our modern Research and Development facility.

- SEMI CONDUCTOR RESEARCH
- LOGIC AND CIRCUIT DESIGN
- COMPONENT EVALUATION
- TECHNICAL WRITING
- ADVANCED ELECTRONIC SYSTEMS
- SYSTEMS RELIABILITY
- DIGITAL COMMUNICATIONS

Positions open are at all levels of experience, including Project Manager. Prompt and personal attention will be given to your inquiry. All qualified applicants will be considered regardless of race, creed, color or national origin.

Send resumé and letter of application to: T. F. Wade, Technical Placement, G-11
The National Cash Register Co.,
Main and K Streets,
Dayton 9, Ohio.

NCR
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National®
ELECTRONIC DATA PROCESSING
ADDING MACHINES • CASH REGISTERS
ACCOUNTING MACHINES
NCR PAPER (NO CARBON REQUIRED)

THE NATIONAL CASH REGISTER COMPANY, DAYTON 9, OHIO

ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

77 YEARS OF HELPING BUSINESS SAVE MONEY

INDEX TO ADVERTISERS

Audited Paid Circulation

• See Advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

INDEX TO CLASSIFED ADVERTISERS

• See Advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

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

electronics

Audit Bureau of Circulations

Associated Business Publications

Audited Paid Circulation

JAMES T. HAUPTLI
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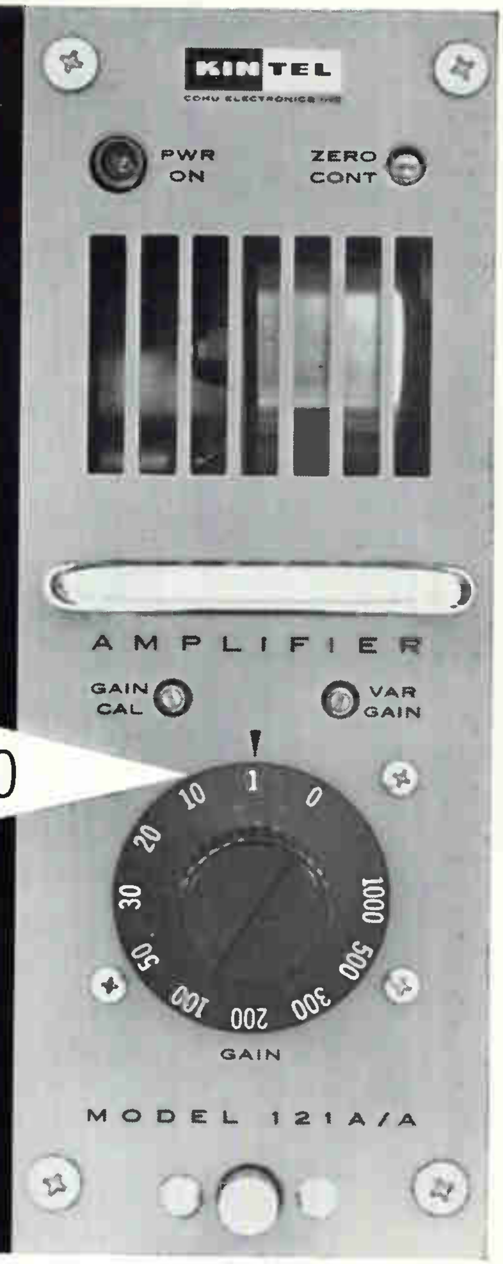
New KIN TEL solid-state DC amplifier gives you

200 kc response...

0.005% linearity...

ten fixed gains from +1 to +1000



KIN TEL'S Model 121A/A non-inverting DC amplifier has fixed gains of 0, +1, +10, +20, +30, +50, +100, +200, +300, +500, and +1000. A variable gain control adjusts any fixed gain from x1 to x2.2. A gain calibration control gives ±2.5% adjustment for each gain other than +1.

With this new instrument, you can amplify accurately all low-level signals from DC to beyond 200 kc for the reliable measurement of strain, temperature, flow, vibration, displacement, or other physical phenomena. The 121A/A has the same dimensions, fits the same cabinets and modules as other KIN TEL DC amplifiers.

For more information on this new, more *usable* DC amplifier, write to KIN TEL. Engineering representatives in all major cities.

ADDITIONAL SPECIFICATION NOTES:

The Model 121A/A is a non-inverting (positive input produces a positive output), wideband, DC amplifier. Amplification is accurate within 0.1% for all gains other than +1 (gain accuracy is 0.2% at +1), linear within 0.005% for outputs up to ±15 volts DC with load impedances of 200 ohms or more. The amplifier provides up to 100 ma—±DC or peak AC—into loads of 100 ohms or less. Input impedance is greater than 10 megohms; output impedance is less than 0.3 ohm. Frequency response is flat within 0.25% to 2 kc, within 4% to 10 kc, within 3 db to 200 kc. Drift is less than ±2.0 μvolts equivalent input for over 40 hours at +1000 gain. Amplifier recovers from 100% overload in 0.4 second, is undamaged by sustained, direct short across output terminals. Price $1000.

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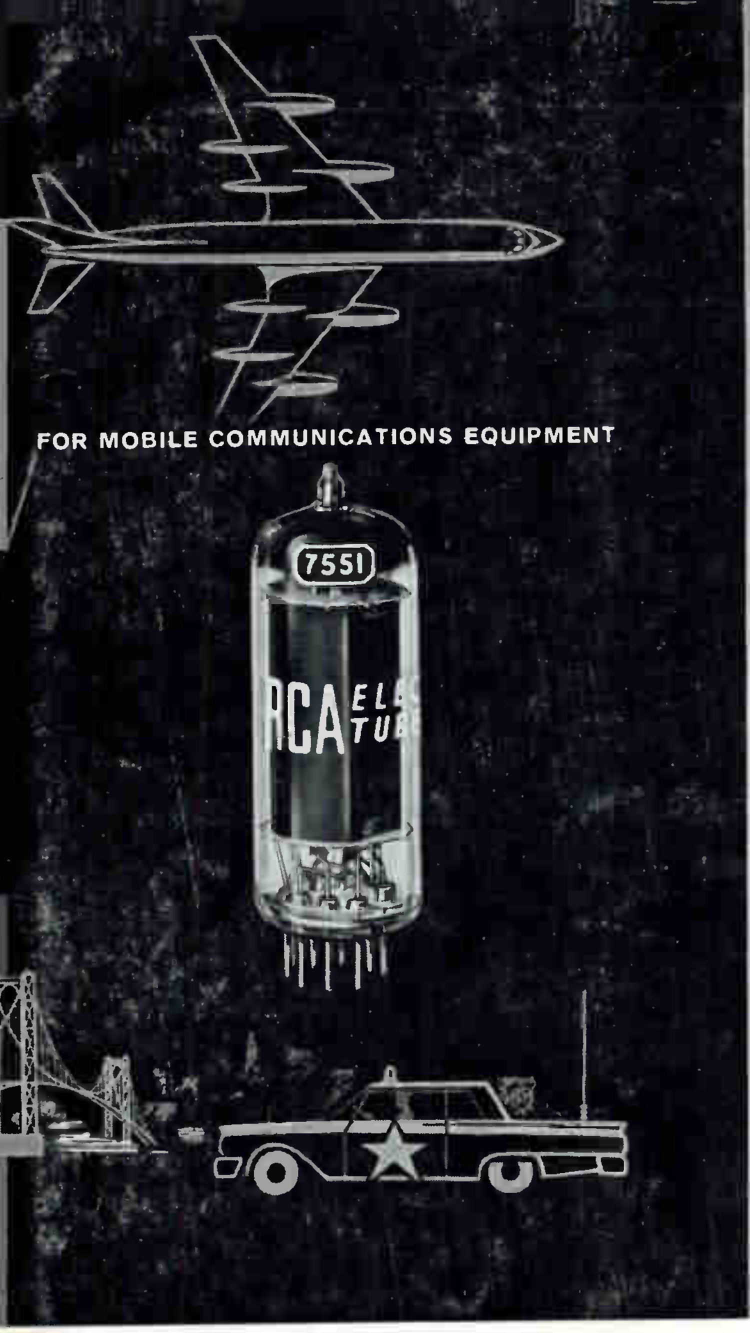
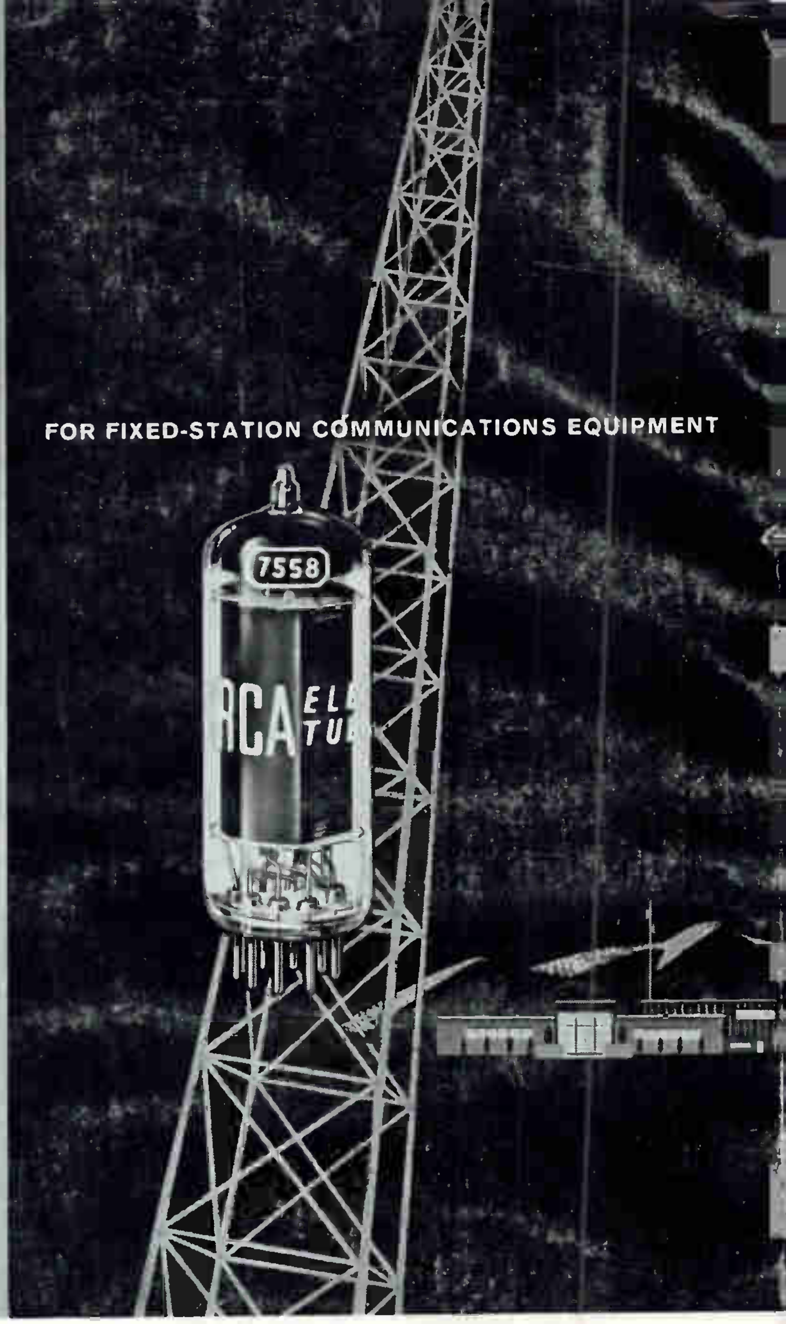
KIN TEL DIVISION





Best Miniature Beam Power Tubes in their Price Class

More performance per dollar is packed into the RCA-7551 and 7558 miniature beam power tubes than in any comparable tubes on the market. With the 7551 and 7558, you can design top-quality communications equipment while keeping costs down.

Either tube gives top performance as a Class C r-f amplifier, oscillator, or frequency-multiplier at frequencies up to 175 Mc. Either may also be used in modulator or a-f power amplifier applications. A pair of either type, in Class AB_1 push-pull a-f amplifier service, can deliver up to 20.5 watts signal power output.

Identical in all respects except for heater ratings, the 7558 has a 6.3-volt heater (for use in fixed-station communications equipment) while the 7551 operates over a fluctuating heater-voltage (12 to 15 volts) such as that encountered in mobile systems operating from 6-cell storage-battery systems. In addition, the 7551 is subjected to rigid controls and tests for heater cycling, H-K leakage, interelectrode leakage, low-frequency vibration, and 500-hour intermittent life—to assure dependable performance in mobile systems.

Features contributing to efficient high-frequency performance of these tubes include:

- *Low lead inductance*
- *Two base-pin connections for both the cathode and the No. 2 grid—to minimize degeneration and facilitate r-f bypassing*
- *Low interelectrode capacitances*
- *Low r-f loss and high input resistance—permit use of high grid-No. 1 circuit resistance to minimize loading of the driver stage.*

These remarkable tubes help you to design compact communications equipment with assurance of dependable performance and long life. See your RCA Field Representative, or write, Commercial Engineering, Section K-19-DE-1, RCA Electron Tube Division, Harrison, New Jersey.

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