November 10, 1961

electronics

A McGraw-Hill Publication 75 Cents

NEREM MEETING

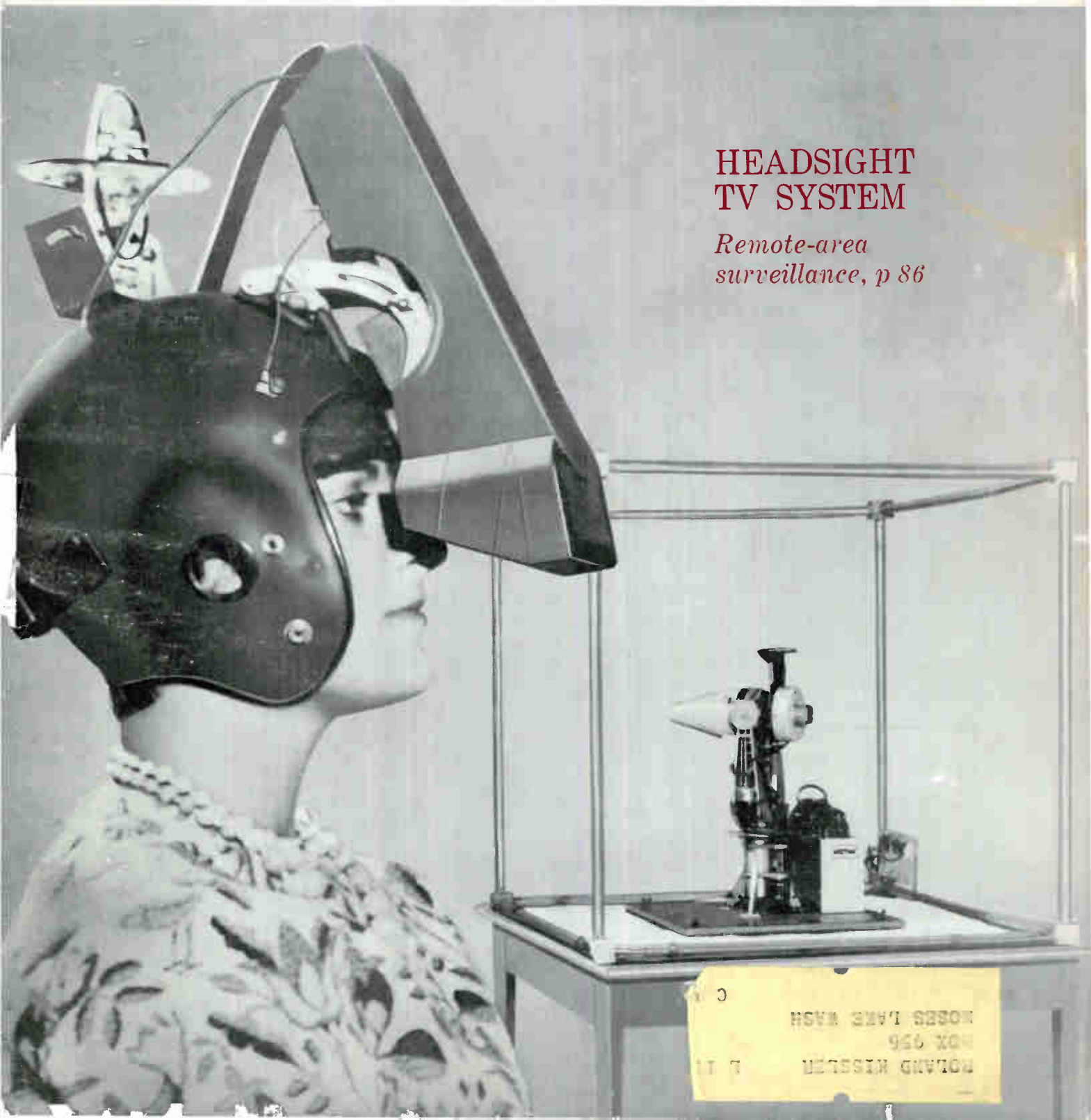
Technical preview, p 73

COAXIAL MAGNETRON

High-power output, p 78

SPEEDUP CIRCUIT

Inverter switching, p 92

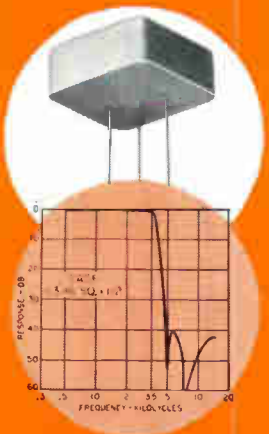


HEADSIGHT TV SYSTEM

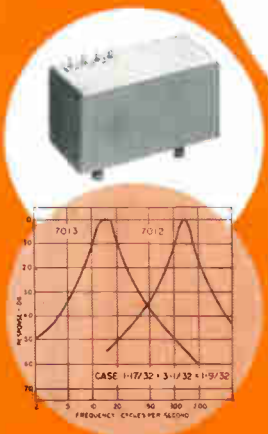
Remote-area surveillance, p 86

SPECIAL FILTERS

TO YOUR REQUIREMENTS

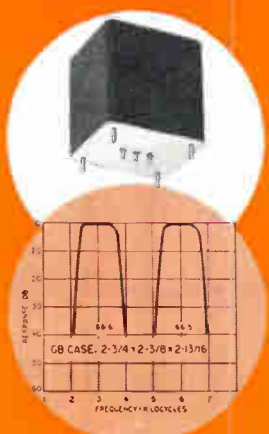


Miniaturized 3.5 KC low pass filter. 10K ohms to 10K ohms. Within 1 db up to 3500 cycles. Greater than 40 db beyond 4800 cycles.

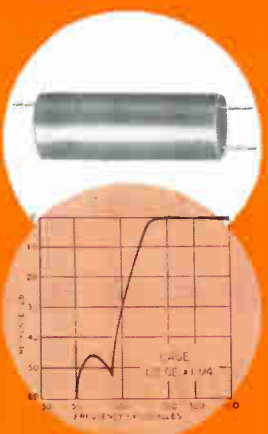


Fifteen cycle and 135 cycle filters for Tacan. 600 ohms to high impedance. Extreme stability —55°C. to + 100°C.

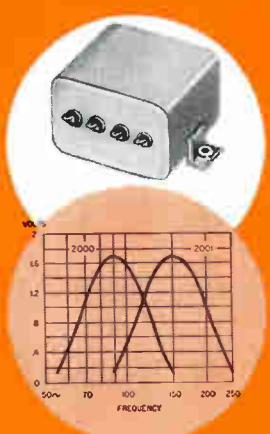
Almost thirty years of experience in the design and production of special filters have resulted in UTC being a first source for difficult units. Present designs incorporate a wide variety of core structures, winding methods, and capacitors to provide maximum performance, stability, and reliability. The units illustrated show a few of the thousands of specials produced by UTC, to customers' requirements, and only slightly indicate the possibilities in present special filter design. Range of frequencies on special units is from .1 cycles to 400 MC.



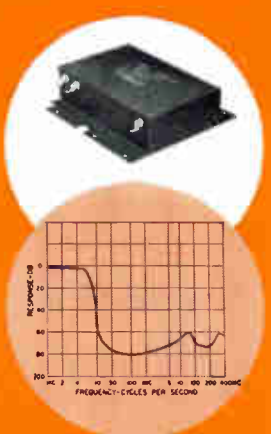
Three KC and 6 KC flat top band pass filters. 400 ohms to 20K ohms. MIL-T-27A; each filter 1.7 lbs.



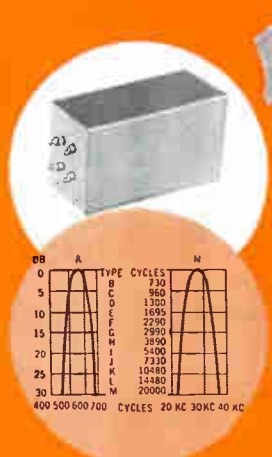
High frequency Mini-filters, .33 oz. MIL-T-27A Grade 5. 150 KC High Pass 3 db to 150 KC, down 45 db below 85 KC. 7500 ohms.



Curves of our miniaturized 90 and 150 cycle filters for glide path systems. 1¼" x 1¾" x 1⅝".



Power line filter from sources of 50 to 400 cycles . . . attentuation from 14 KC to 400 MC . . . 29 cubic inches.



Multi-channel telemetering band pass filters for 400 cycle to 40 KC. Miniaturized units for many applications.

Plus over 1,000 STOCK ITEMS with UTC High Reliability from your local distributor

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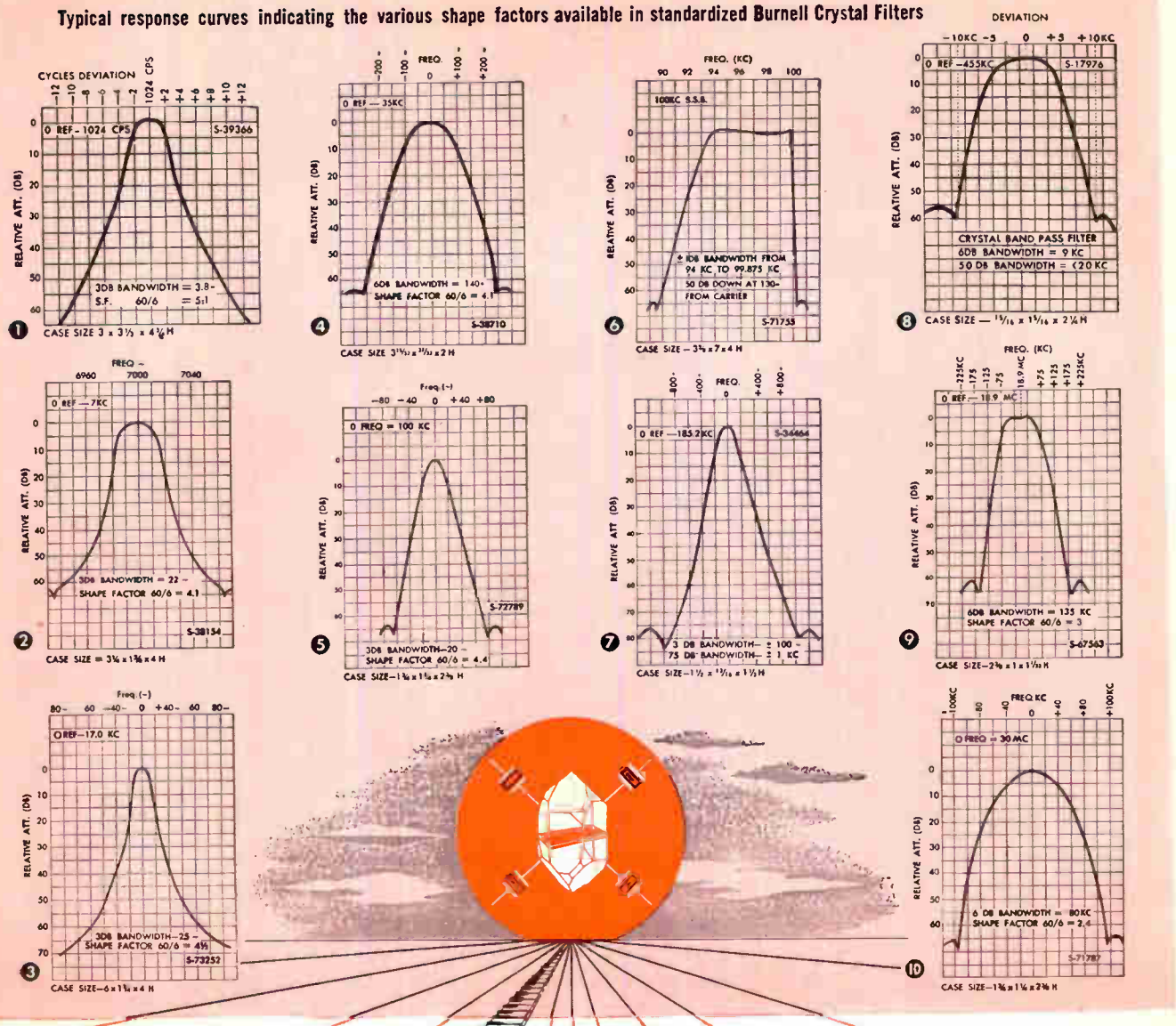
November 10, 1961

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

Typical response curves indicating the various shape factors available in standardized Burnell Crystal Filters



Running the gamut in crystal filters

BURNELL CRYSTAL FILTERS NOW COVER FULLEST RANGE YET POSSIBLE

1 kc to 30 mcs

To its notable achievements in advancing the electronic arts, Burnell & Co. now adds another—the development of moderately priced high attenuation crystal filters covering the extraordinary range of 1 kc. to 30 mc. This represents a range many times broader than previously thought practicable. In addition, the Burnell Crystal Filter line now includes several types heretofore considered impossible.

More than 15 years research, development and experience are represented in the designs illustrated in the response curves shown. Burnell & Co. has taken crystal filters out of the luxury class in applying its experience to their design and manufacturing without incurring developmental and engineering costs.

Whether your crystal filter needs are for standard units or those engineered to center frequency, band width, selectivity and impedance level, call on our Crystal Filter Division for quick delivery. Send now for Crystal Filter Catalog, XT455.

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CROSSTALK

ASK A BOSTONIAN what his favorite industry is and he will probably answer, "electronics". While New England Editor Maguire was collecting information for his NEREM previews in this issue (pages 32 and 73) he spoke with Ephron Catlin, Jr., president of the Greater Boston Chamber of Commerce.

Catlin calls the laboratories which have sprung up in and around Hanscom Field, MIT, Harvard and other institutions "the real guts of our economy, now that our textile and shoe industries have been falling on their faces". MIT, he said, "is the greatest single economic asset of any city in the free world".

Boston has good reason to be a willing host to NEREM. Since World War II, more than 400 science-oriented enterprises have been started in the Boston area. Most are in electronics. Many will be displaying their best new products in the exhibit hall (photo) next week.

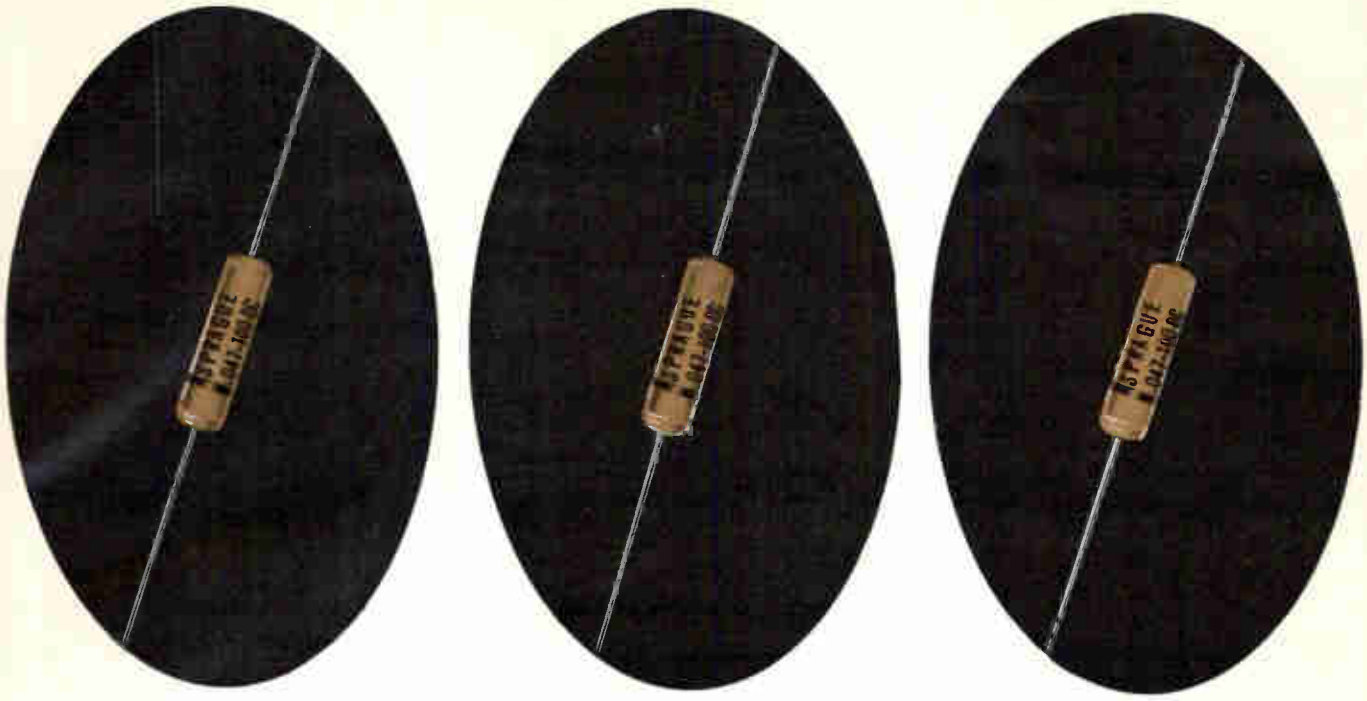
VIDICON CAMERA that gives an observer a sense of presence at a scene several hundred miles away is described on p 86 by C. P. Comeau and J. S. Bryan, of Philco's research division. Mounted, for example, in a spacecraft, the camera follows the head motions of an operator sitting safely on the ground.

Coming In Our November 17 Issue

SPECIAL REPORT. Missile and space technology is one of the most dynamic and fascinating areas of our industry. Vast strides have been made since our April 24, 1959, special report on the first days of the space age. Even though the first steps are being taken toward exploring the planets, we are still only at the beginning.

Next week ELECTRONICS brings you a 32-page special report on the vital subject of electronics for missiles and spacecraft. To bring you this comprehensive survey, Associate Editor Mason and Senior Associate Editor Wolff have spent months talking with experts in government agencies, private companies and scientific and academic institutions.

You'll read about future plans, and trends in electronic equipment for guidance and control, data acquisition and transmission, propulsion and power generation, missile ranges and launch sites, ground tracking networks, detection, and radio and radar astronomy.



TINY... TAN... TERRIFIC!

Latest space-maker for size-conscious designers of transistorized commercial and entertainment equipment is the new *Sprague Type 157P Molded-case Filmite® "E" Capacitor,* which combines unusual compactness with exceptional performance characteristics.

Distinctive *tan coloring* identifies the Type 157P Capacitor and serves as your warranty of outstanding shock-and-humidity resistance. The tough molded armor also protects against possible damage during soldering operations, or changes in capacitance from mechanical pressure where wrapped capacitors are clamped or cast in assemblies.

Standard operating temperature range is −40 C to +85 C. And with voltage derating, this outstanding capacitor may be operated to +105 C! Its high insulation resistance (due to the polyester film dielectric and molded housing) is another characteristic which qualifies the 157P Capacitor for critical coupling applications.


SPRAGUE Engineering Bulletin 2065

MOLDED-CASE FILMITE "E" CAPACITORS

For complete technical data on Type 157P Filmite "E" Capacitors, write for Engineering Bulletin 2065 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Mass.

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THE MARK OF RELIABILITY

COMMENT

Inventions Wanted

Some time ago a list was published of new inventions needed by the armed services. Knowing the reputation of your publication, we felt that contacting you was our best chance to obtain this list. What is desired is something similar, only more extensive, to the article entitled Defense Needs Electronics Inventions, which appeared in the July 28 issue (p 26). Mainly we would like a list of inventions needed by the armed services, but one tabulating those needed in the commercial field would also be valuable. If you have access to this information, we would appreciate your passing it along to us.

The timeliness and foresight of your publication makes it of great value to our systems group.

DAVID E. DOWNIE
Melabs
Palo Alto, California

The article was based on a 14-page booklet, Inventions Wanted By The Armed Forces And Other Government Agencies, published by the National Inventors Council, U. S. Department of Commerce, Washington 25, D. C. The booklet is a supplement to prior issues of Inventions Wanted, which are available in a cumulative reprint from the Council or the nearest field office of the Department of Commerce, as is the booklet itself.

The booklet lists 89 inventions wanted, in categories such as Aeronautics, Applied Mechanics, Chemistry, Electronics, and Instrumentation. Some of the inventions wanted are listed with a simple statement of requirements; others also give background information or status of the problem.

The Council is interested in all ideas that may be of value to the military agencies or other branches of the government, but not in inventions of primary interest to a civilian market.

Many of the inventions listed do have commercial applications, such as a fast linear recorder, a linear sawtooth generator, high-energy solar radiation sources, and devices for prevention of mid-air collisions.

We do not know of any tabulation of needed commercial inventions, nor does it seem likely that such a listing would exist. But if any of our readers have information on the subject, we'd like to hear about it.

Word From Down Under

I would like to take advantage of your offer in the November 11, 1960, issue of ELECTRONICS (p 132), rather belatedly, for the booklet How To Cut Your Reading Time. If there are spare copies, two engineers in my office would be very grateful to receive a booklet.

We are engineers in the Radio Section of the Australian Post Office, engaged in radio, telephone and broadcasting. Your journal is regularly circulated through our engineering library, and, as you can see, is very well read by all engineers in the Post Office.

I personally find the present format very good, particularly the *Electronics Newsletter*, which I prefer to think of as a "stop press."

The nomographs are always of interest, along with *New on the Market*.

In short, I would say that your journal is a must for the radio engineer today if he wishes to keep abreast of scientific advances.

JACK E. BURGESSON
Cheltenham, Victoria
Australia

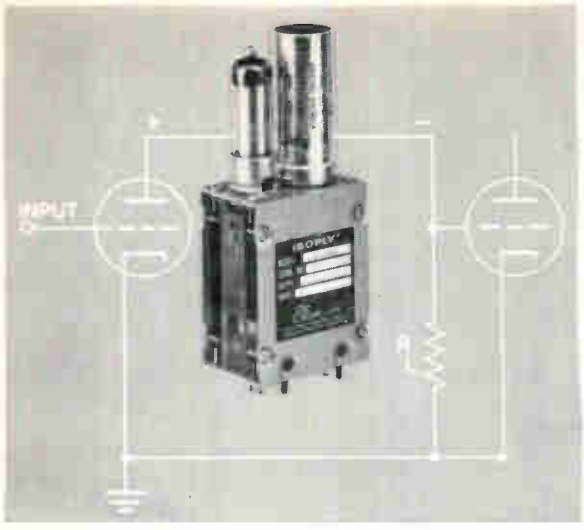
Newsletter is in fact sent to the presses later than the rest of the magazine, so that we can print last-minute news.

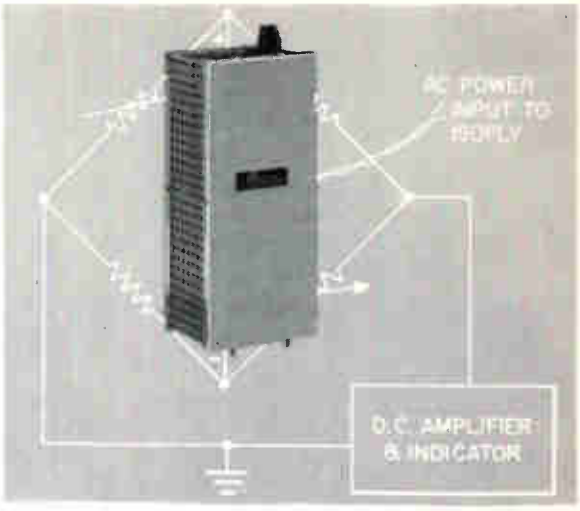
Rectification Efficiency

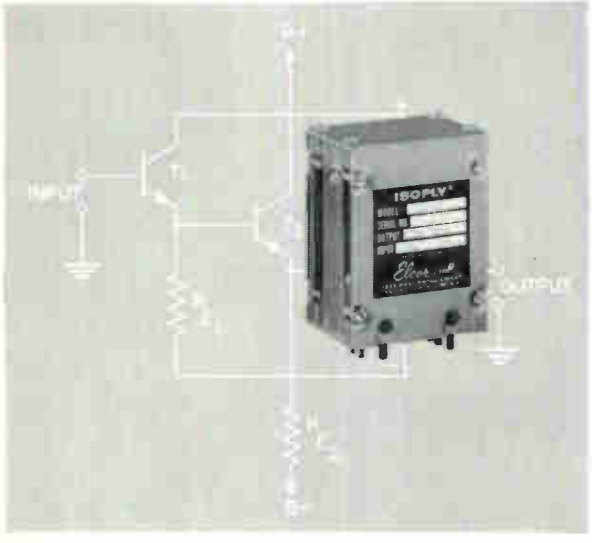
I have a comment on the letter concerning rectification efficiency (*Comment*, October 13, p 7).

Reader Pinnell is perfectly correct that for an ideal rectifier the ratio of the *total* load power to input power yields an efficiency of 100 percent. That, however, is not the definition of conversion efficiency, which is defined as 100 percent times the ratio of the *d-c* load power to the input power. A Fourier series of the load voltage shows it to be composed of a d-c term plus numerous a-c ripple components. The d-c load power is defined as $(E_{dc})^2/R_L$ or $E_{dc}I_{dc}$ and is thus less than the input power by the factor 0.812 in the ideal case in question.

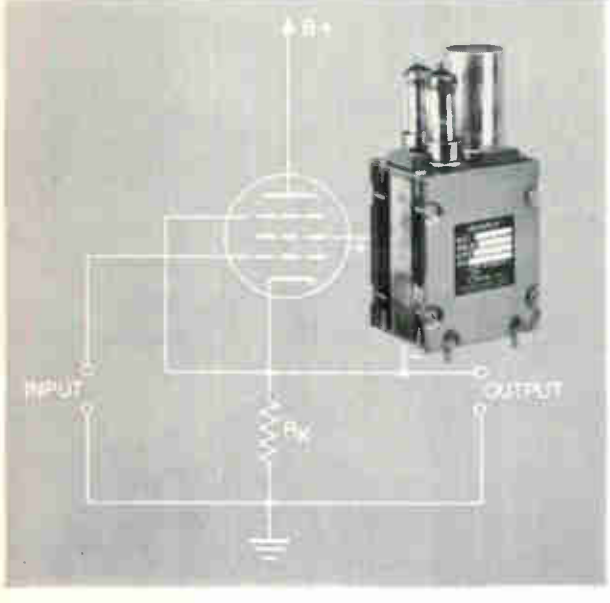
DON G. DAUGHERTY
Madison, Wisconsin







Circuit designs made simpler and more economical with new Elcor ISOPLYS®



Isoplys (isolated power supplies) can be used ungrounded. Unlike conventional power supplies, Isoplys have low shunt capacitance to ground and low noise in ungrounded applications. They are relatively insensitive to power line fluctuations and give excellent frequency response.

Many components once thought essential in conventional circuits can be eliminated. Design and assembly time can be speeded. Troublesome interaction between circuits is substantially reduced. This also helps simplify maintenance as well as solve difficult circuit problems.

Let Isoplys help simplify a circuit design you are working on now. Be prepared for design problems in the future.

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Transient Voltages...Cause and Cure

A transient voltage can be generated whenever a magnetic component is energized, or de-energized. The peak amplitude of the spike can be many times the normal steady state peak inverse voltage, and is dependent on the amount of magnetic energy stored in the circuit and the rate of change of the collapse of the resultant flux field.

The amount of magnetic energy stored in various circuit reactances can be approximated by $L\frac{i^2}{2}$, and this energy, when current is interrupted can produce a voltage equal to $L\frac{di}{dt}$. It is apparent, therefore, that under severe load or overload conditions, a high level transient voltage with substantial energy can be generated.

In actual applications, transients are generated mainly through interruption of current by switching, although circuit characteristics and phenomena can contribute to the problem. Full advantages to be gained from silicon rectifiers are available only if they are properly applied and protected. Silicon rectifiers have low inverse voltage capabilities and thermal capacity, so any overvoltage condition, even for a few microseconds, can destroy the junction. The circuits illustrated are typical of those where problems have been found.

In addition to the three most common causes, less obvious circuits and phenomena can generate transients. Among these are minority carrier recovery, switching magnetic amplifiers, lightning or random line conditions and motor regeneration.

The problem of computing C or RC filters is complicated because of the possibility of changing circuit operating parameters or causing oscillation.

Tarzian's recently developed line of "klipvolt" selenium transient voltage suppressors, therefore, offers a relatively low cost, simply applied method of positive protection. In many applications, a "klipvolt" suppressor will reduce overall circuit cost and increase reliability. The accompanying table covers the important design factors of voltage and current that govern typical application of suppressors; however, special designs and ratings are available on request. There are two basic types of suppressors, the non-polarized for use primarily across AC components, and the polarized for use in DC load circuits. In some instances, however, it may be preferable to use non-polarized suppressors in output circuits for more positive clamping or non-interference with circuit timing or operation.

Switching in Primary—Transients are caused by interruption of "magnetic" current, or by energizing the primary and causing oscillation between inductance and distributed capacity.

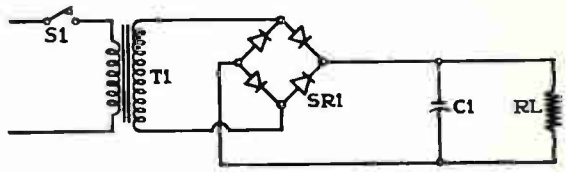


FIGURE 1

Switching Load—When the load is switched, the magnetic energy stored in the input circuit generates a voltage across the rectifiers and switch.

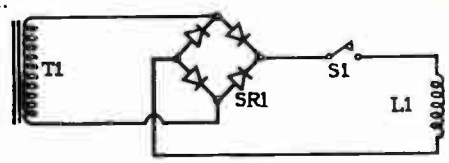


FIGURE 2

Magnetic Components on Common Line—Other magnetic components like motors, solenoids, relays or breakers can generate a transient peak when input is interrupted. The generated voltage will appear across the rectifier.

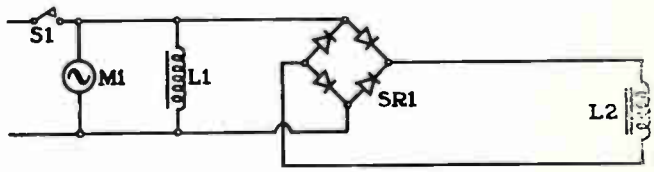
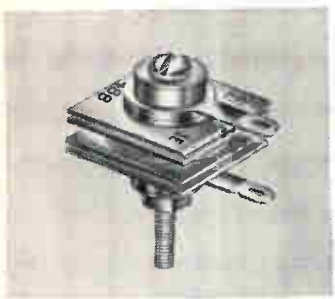


FIGURE 3

TYPICAL *klipvolt* SUPPRESSORS—SINGLE PHASE



DC LOAD CURRENT		0-35	36-55	56-100	101-110	110-200	201-350
PIV	RMS VOLTS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS
50	35	S-487	S-487A	S-487B	S-487A	S-487B	S-487C
100	70	S-488	S-488A	S-488B	S-488A	S-488B	S-488C
200	140	S-490	S-490A	S-490B	S-490A	S-490B	S-490C
300	210	S-492	S-492A	S-492B	S-492A	S-492B	S-492C
400	280	S-493	S-493A	S-493B	S-493A	S-493B	S-493C
500	350	S-494	S-494A	S-494B	S-494A	S-494B	S-494C
600	420	S-495	S-495A	S-495B	S-495A	S-495B	S-495C

TYPICAL THREE PHASE SUPPRESSORS

DC LOAD CURRENT		0-60a		61-115a		116-200a		201-450a	
PIV	RMS VOLTS	H.W.	BR	H.W.	BR	H.W.	BR	H.W.	BR
50	35	S-539	S-539	S-539	S-539A	S-539A	S-539B	S-539B	S-539C
100	70	S-540	S-540	S-540	S-540A	S-540A	S-540B	S-540B	S-540C
200	140	S-542	S-542	S-542	S-542A	S-542A	S-542B	S-542B	S-542C
300	210	S-544	S-544	S-544	S-544A	S-544A	S-544B	S-544B	S-544C

Note: All types without suffix letter use plates 1" square; with "A"—1¼", with "B"—1.6"; and with "C"—2" square. Length depends on voltage rating and varies from 1⅜" to 4¾".

Write for complete "klipvolt" application information.

ELECTRONICS NEWSLETTER

Big Bomb's Aim to Destroy Communications?

PROPONENTS of atmospheric A-bomb tests by the U.S. were pointing out last week that such tests were essential to development of weapons able to jam enemy communications.

There is evidence in recent Communist propaganda broadcasts that development of jamming bombs was, in fact, the real reason why the USSR exploded its 50-megaton-plus bomb despite world-wide pleas and condemnation.

Said an East German broadcast: "It is now dawning on them (the Western allies) that the USSR with one single nuclear weapon of 100 megatons can, for all practical purposes, put the entire electronic system of the United State out of action".

USSR bombs have been dirty ones. Apparently, for electronic countermeasures, the dirtier the better.

NASA has reported that high concentrations of electron particles in radiation belts can jam radio and radar signals. The charged particles absorb r-f energy, causing radio blackouts or obscuring radar targets.

Coupled with the East German comment, this implies that a few well-placed big bombs, fired in advance of a saturation missile attack, could affect our communications and detection systems enough to snarl a retaliatory attack.

Feasibility of jamming with bombs was indicated by Project Argus in 1958 when two nuclear warheads were exploded high above Johnston Island in the Pacific.

Report prepared for Congress by the Rand Corp. said the blasts disrupted radio communications, especially at 5 Mc to 25 Mc. Most links within a few hundred miles of the island experienced outages up to several hours at various periods for about a day. The effect on h-f communications was like that of a giant solar flare.

These factors also indicate why Communist propaganda broadcasts have been vehemently opposing our Project West Ford and reiterating protests made by astronomers.

One purpose of West Ford's orbiting belt of tuned dipoles is to free over-the-horizon scatter system from dependence on stability of transmission properties of the upper atmosphere. The belt would provide an artificial reflecting medium in space.

West Ford's importance is underscored by the fact that the decision to go ahead, despite astronomers' protests, was made at the top—by President Kennedy.

Ionospheric and tropospheric scatter systems provide a major portion of the West's long-distance military communications. The USSR is understood to be concentrating on wireline and point-to-point relay systems.

Cryogenics Give Magnet Researchers High Hopes

CRYOGENIC techniques were in the spotlight at the Air Force-sponsored First International Conference on High Magnetic Fields at MIT. The conference was attended by 500 scientists and engineers from 12 nations.

Applications being explored include combining high magnetic fields and superconducting electromagnetic lenses to extend resolution of electron microscopes by a factor of 100. Macromolecular structures in biological systems could be visualized.

Dr. H. Fernandez-Moran, of Massachusetts General Hospital, added that such microscopes could view lattice strains in metals and single dislocations in crystals. Advances may also permit use of microbeams as information storage tools and for fabrication of printed circuits the size of blood corpuscles.

Other reports discussed included lightweight radiation shielding for space vehicles and miniaturizing MHD power and propulsion plants. Prof. Francis Ritter predicted 500,000-gauss constant fields would be attained by combining superconductivity, long pulse and water-cooling techniques.

No Loud Ties, We Hope

DALLAS—For the girlfriend of the man who has everything, Neiman-Marcus had an answer recently.

The department store programmed a computer to cross-check its inventory against data on potential gift receivers and price, to give a customer 10 probably acceptable gifts.

Sample query: gift costing over $1,000 for a 12-year-old boy. Answer: monopoly game to be played with real money.

IBM loaned a computer for the two-week promotion stunt. It handled about 2,000 queries a day.

Metal-Porcelain Sandwich Changes Heat to Power

WESTINGHOUSE ELECTRIC reports that when certain metals are separated by porcelain enamel and heated, electric power is produced. One of these cells the size of a slice of bread placed in an electric toaster produced enough power to drive a small electric motor. Westinghouse has a $75,000 Air Force contract to research applications. The cells—called Austin cells for B. O. Austin, the developer—could probably utilize waste heat in rocket exhausts.

Solid-State Components Feature of Tokyo Show

TOKYO—Japanese component manufacturers at the 1962 Japan Electronic Parts Show went all-out to display their best products to foreign buyers. Consumer products took a back seat to basic components, materials and integrated modules.

Several companies showed microminiature modules in the wafer size used by the U.S. Signal Corps. Resistor manufacturers said they would produce to MIL specs. New

types of transistors and diodes were featured.

Some products were so new neither catalogs nor literature were available. Catalogs in English were available from many manufacturers and one firm labeled its display only in English. Attendance exceeded 40,000.

RCA Sells 150 Computers To British and French

RCA HAS ANNOUNCED terms of its recent multimillion dollar agreements with British and French firms:

International Computers and Tabulators Ltd. will buy 50 data processing systems by 1964 and has options for 50 more. The two firms exchange nonexclusive patent licenses and knowhow.

Compagnie des Machines Bull buys 100 computers and has options for another 100.

Doppler Alarm Catches Burglars over 50 Lb

MOTION-SENSITIVE doppler radar developed by Sylvania sounds an alarm when an intruder attempts to enter a protected area. The miniature system is reported to reliably detect moving objects weighing 50 pounds or more which have specific gravity similar to that of humans.

Foot-high transmitter and receiver units are located at separate stations to produce an electromagnetic field in the area to be protected. Signals generated by entry of objects into the field are analyzed. If it is a person, an alarm is triggered. Component failure, tampering or jamming attempts also set off alarms.

Program to Stimulate Science in Midwest

PROGRAM TO EXPAND science, education and industry in six states has been jointly announced by James E. Webb, NASA administrator, and Charles N. Kimball, president of Midwest Research Institute, Kansas City.

MRI, working with universities and industry in Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma, will spend $250,000 annually to bring more space research and education into the area and to stimulate local industries to make use of space technology.

NASA will be kept informed of unexploited technical capabilities and local industry will be advised of untapped commercial opportunities in techniques developed for space.

Zener Diode Barrier Capacitance Only 5 pf

TOKYO—High-frequency zener diodes with typical barrier capacitances of 5 pf have been jointly developed by Nippon T&T Public Corp. and Nippon Electric Co. Voltage change is about 0.02 v for current changes of 5 to 500 μa. These compare with several hundred pf and 0.2 v for conventional zener diodes made by NEC.

The diodes have been tried in a variety of pulse circuits, including limiters, clippers, shapers, subtractors and discriminators, with reportedly superior results. Output of a clipped clamper, for example, is said to have square corners while the waveshape from conventional diodes were round and elongated.

Radio Conferees Stress Consumer Gear Reliability

RELIABILITY and the development of product warrantees for stereo and other consumer electronics products were given a close look at the Radio Fall Meeting in Syracuse last week.

Speakers pointed out ways in which improved reliability would benefit manufacturers. A. B. Mundel, of Sonotone, said the goals are the same as in military reliability: economic performance, reduction of repairs and replacements.

Reliability programs are not too expensive, according to G. R. Herd, of Booz, Allen Applied Research. A commercial manufacturer, he said, has a greater stake in reliability because customers are responsive to economic affects of reliability lapses.

In Brief . . .

BURROUGHS reports it has accepted over $20 million in contracts during the past 30 days for its new B200 series computers, at prices ranging from $165,000 to $585,000.

AUTOMATIC ELECTRIC has installed a 94-station, two-way Teletypewriter network in Chicago police stations.

U. S. PATENT OFFICE is observing its 125th anniversary. The three-millionth patent was awarded this year.

LATEST NIKE-ZEUS contract from Army to Western Electric totals $20.5 million for ground equipment. Ampex has a $500,000 contract from Bell Labs for video tape recorders for Zeus.

MINUTEMAN contracts include $321,258 to United Electro-Dynamics for digital telemetering and ground support equipment: $300,000 to Texas Instruments for electro-optical guidance system aligners.

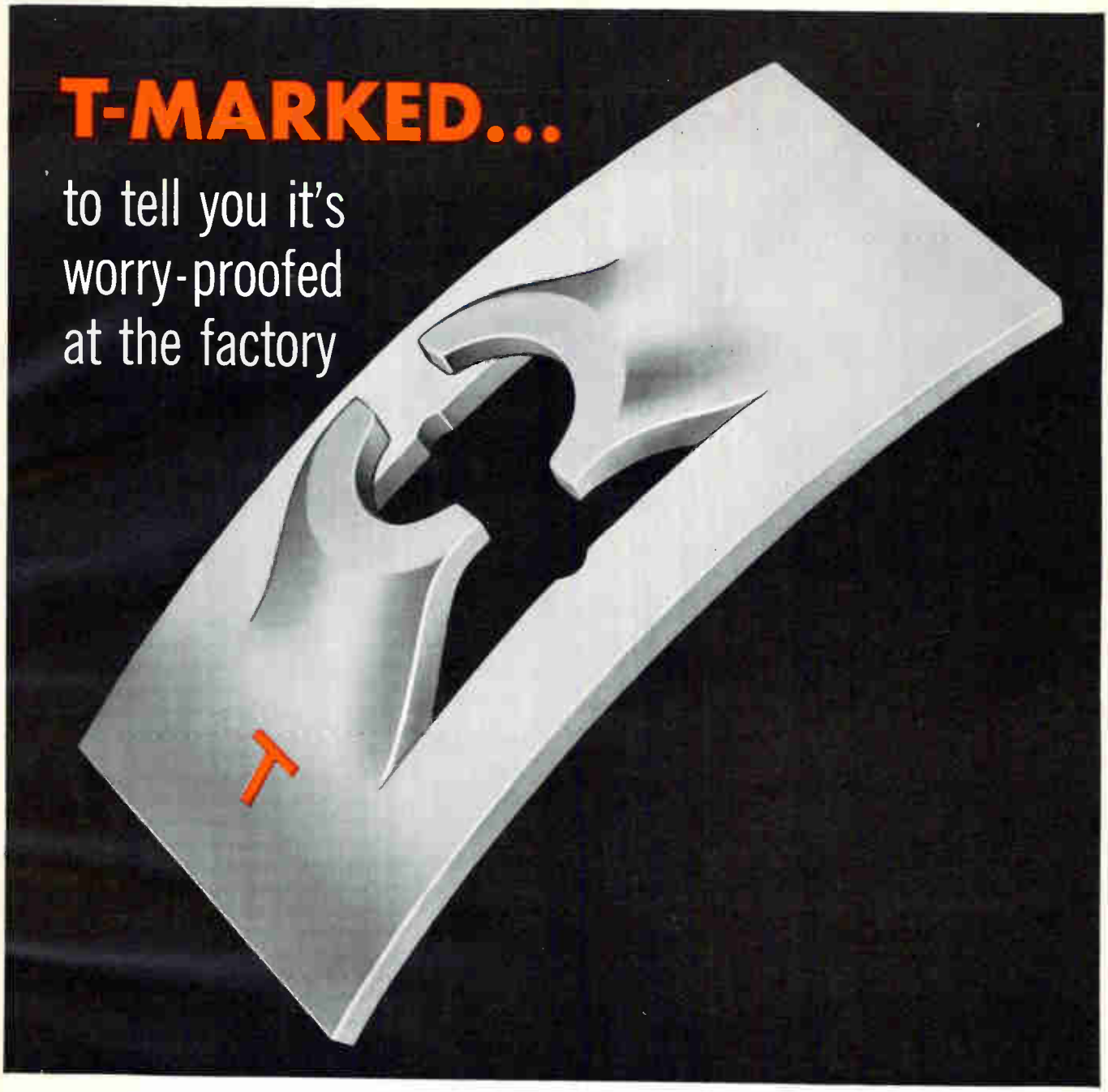
SYLVANIA won $372,000 contract for Polaris fire control system modules, and $314,000 in expendable radar deceivers.

OTHER missile and space contracts include $2 million to Benrus for a variety of equipment; Dage division of TRW, $800,000 for closed circuit tv; $130,000 to Electro-Mechanical Research for satellite telemetry; $500,000 to ACF for missile radar beacons.

COLLINS contracts include $890,000 for fighter plane and helicopter navigation instruments.

RAYTHEON is supplying FAA with 11 more bright displays for airport radar, at $1.6 million.

NAVY contracts include $675,000 to TRW for missile range computers; $600,000 to U. S. Sonics for hydrophones; $360,000 to Cardion Electronics for weather radar and $500,000 to Consolidated Electrodynamics for depth transducers.



Other spring fasteners may look like Tinnerman SPEED NUTS. But only the *T-marked* ones really are SPEED NUTS . . . really are "Tinnermans". . . made to highest quality and precision standards to assure worry-proof performance on your assembly.

Here's what the exclusive Tinnerman T-mark means to fastener users:

Over thirty-five years of Tinnerman experience as the originator and largest producer of spring-steel fasteners...the leader in solving your fastening problems,

Outstanding fastener design and production experience that assures you the best possible design of SPEED NUT, whether it is a special SPEED NUT or one of the 10,000 SPEED NUT brand fasteners presently available,

Stringent control of SPEED NUT quality from coil strip to you, including die design, production, heat treatment and finishing.

Be sure you specify "Tinnerman T-marked SPEED NUTS" that give you better fastening, that cut parts and assembly costs, that never let you or your customer down. *Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland 1, Ohio.*

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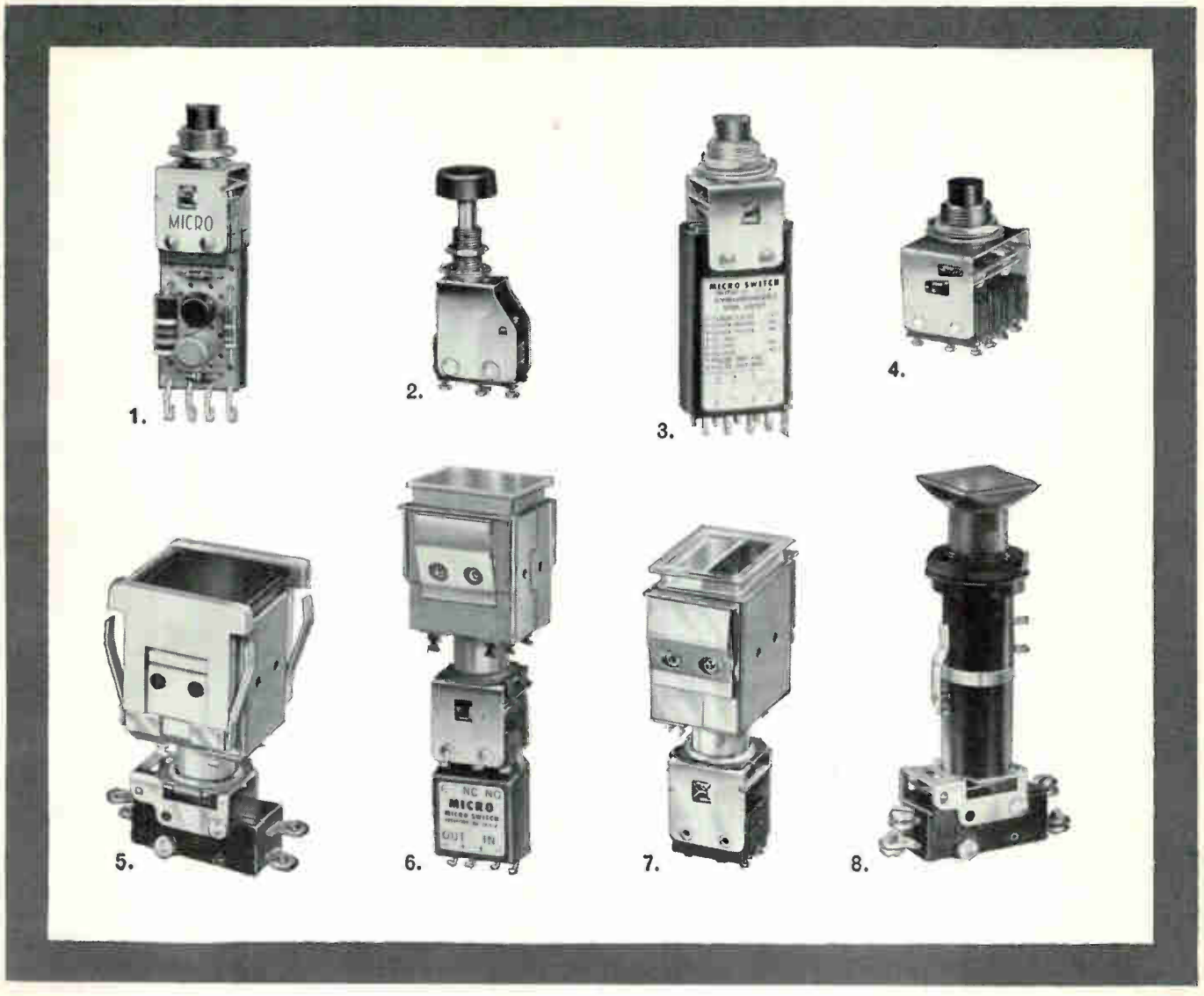

for electronic control panels

CUSTOM-BUILT CONTROL PANELS REQUIRE CAREFUL SELECTION OF SWITCHES

Immediately available are hundreds of small size switch units with variations in dimension, electrical capacity, shape, appearance and circuitry. All have undergone thorough tests in the most complete test laboratory of its kind.

Shown above and briefly described here are only a few of the hundreds of types of switch assemblies available.

1. Electronic switch-circuit for bounce-free voltage output.
2. Light force, rapid repeat pushbutton.
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4. Compact, 4-pole snap-action pushbutton.
5. Lighted pushbutton, modular design, barrier mount.
6. Lighted pushbutton, electronic "one-shot" switch-circuit.
7. Two-color lighted pushbutton, snap-in flange mounting.
8. Bushing mount lighted pushbutton, high capacity, 2-ckt switch.

For more information and for experienced help in selection, contact one of our many branch offices listed in the Yellow Pages, or write for Catalog 67 and Bulletin 22.

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CIRCLE 13 ON READER SERVICE CARD 13

WASHINGTON OUTLOOK

DEFENSE SECRETARY McNamara is considering a major organizational overhaul of the Army's technical services. The result is likely to be consolidation of Army contracting for electronic research, development, and production into a new "Logistics Command." Signals Corps and Ordnance Corps, which now buy the Army's electronics, would probably be limited in function to the training of troops. (A recent Signal Corps development was the lightweight field transceiver shown at right.)

This would be still another step in the Kennedy administration's drive to centralize control over military procurement. A Defense Supply Agency has already been set up to handle all military buying of common-use, commercial-type goods—to eventually include electronic parts.

NEW RESTRICTIONS on patent rights of electronics contractors working on space communications development projects are coming from the Pentagon. Purpose is to assure the availability of Defense Department-financed inventions to all companies engaged in commercial space communications operations.

Under the Defense Department's basic policy on patents, a contractor can take title to an invention. The military gets a royalty-free license and can sublicense other firms to use the patent on military work. Now the Pentagon will be able to sublicense the use of patents in the space communications field for commercial work, too.

SEN. HUBERT H. HUMPHREY (D., Minn.), chairman of a Senate subcommittee studying federal supported medical research, calls for a "vast expansion" in government spending on medical electronic R&D.

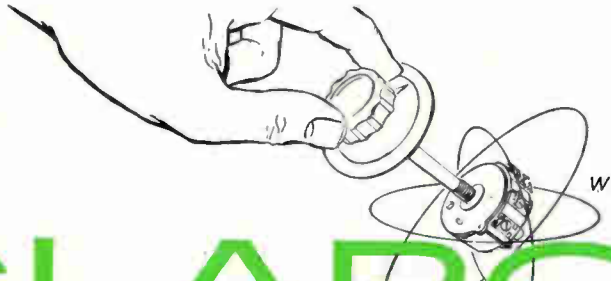
He says there are now 273 "extra-mural" medical electronic research projects amounting to only $8.4 million (plus 93 in-house projects), urges a "systematic, coordinated effort so that medical science can capitalize for civilian purposes on defense-supported discoveries and technology".

Copies of a new Humphrey subcommittee report on activities in medical electronics can be obtained from Rm. 162, Old Senate Office Bldg., Washington 25, D. C.

DEFENSE DEPARTMENT has again decided not to spend the $780 million extra funds appropriated to Air Force for more B-52 bombers and for speedups in development of B-70 and Dynasoar (ELECTRONICS, p 14, Sept. 29). Extra spending for B-70 would have resulted in large electronics contracts, but now only a few stripped down prototypes for air testing will be built.

Precision in miniaturization. The Clarostat Series 57M ½" diameter potentiometer is designed for use as a pad or trimmer under extreme temperature, moisture, shock and vibration conditions. Series 57EM utilizes glass sealed terminals for operation up to 150°C.

Brief specifications: 57M — 1.75 watts @ 70°C; 57EM — 2.0 watts @ 70°C; Dielectric strength — 1000 volts AC; Maximum resistance standard, up to 25,000 ohms, special up to 100,000 ohms; Resistance tolerance ± 10%, on special order to ± 3%; Functional output linear; Independent linearity ±2%.



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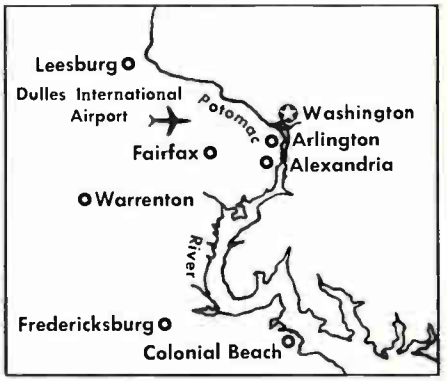
Single-Place Gyrocopter by Bensen Aircraft Corp.

Looking for production savings?

Look into Northern Virginia

Planning a research center or light technical plant? You'll find important savings of productive time in being close to the matchless research facilities of the Nation's Capital. And the area's air facilities, including new Dulles International Airport, put you close to research and scientific operations throughout the world. Write, wire or phone VEPCO for available site and economic data on this area's hospitable communities, where trained personnel find congenial living and a rich cultural life.



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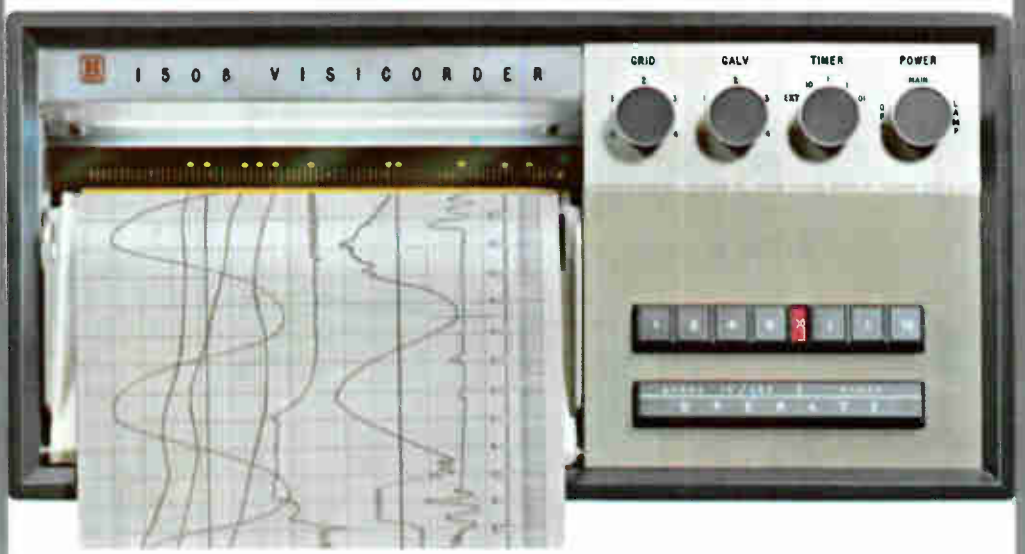
Clark P. Spellman, Manager—Area Development, Electric Building, Richmond 9, Virginia • MIlton 9-1411
Serving the Top-of-the-South with 2,086,000 kilowatts—due to reach 2,720,000 kilowatts by 1963.

CIRCLE 17 ON READER SERVICE CARD→

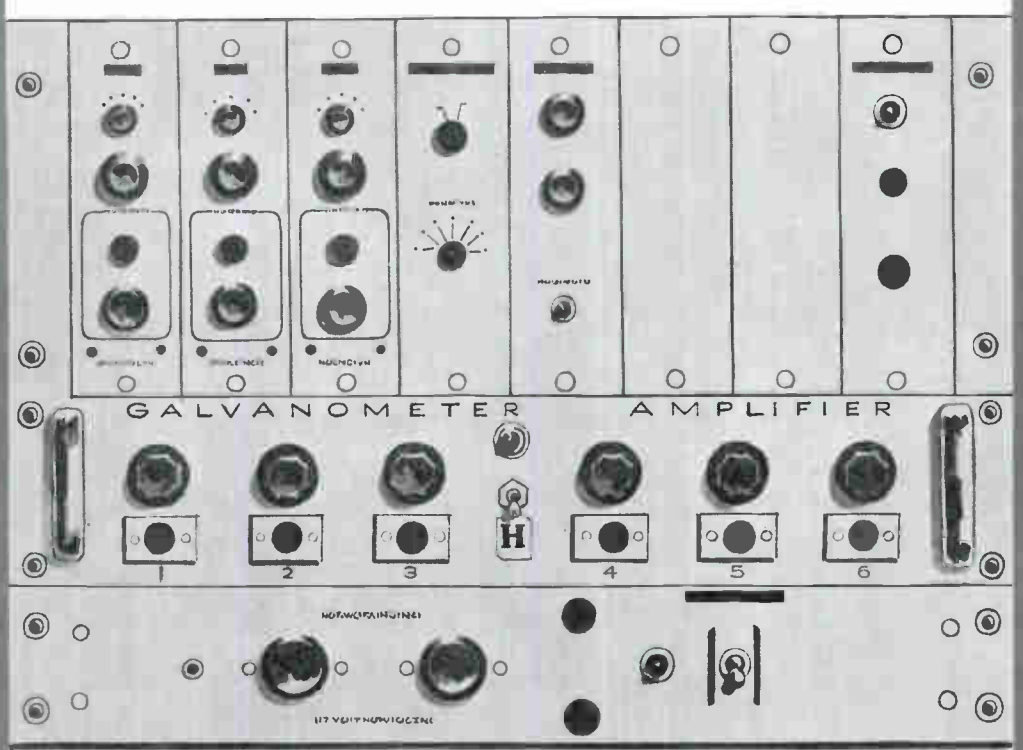
New . . . for systems use . . . the

Rack Mounted

MODEL 1508 HONEYWELL VISICORDER OSCILLOGRAPH



Specifically designed to fit in only 7 inches of rack height, the Model 1508 Visicorder Oscillograph gives you a wider record, a greater record speed range, and more recording channels in less rack space than any other recording oscillograph.



Features of the Model 1508 Visicorder Oscillograph

Using the famous Visicorder direct-recording principle that was pioneered, developed, and introduced by Honeywell, the New Model 1508 oscillograph records up to 24 channels of information simultaneously, producing immediately readable analog records without ink, styli, heat, powders, or chemical processing. Yet it is extremely compact—occupying only 7 inches of height in its rack-mount version—with many automatic features and the convenience of pushbutton controls. It is also available in a bench-mount model.

Maximum Operating Convenience

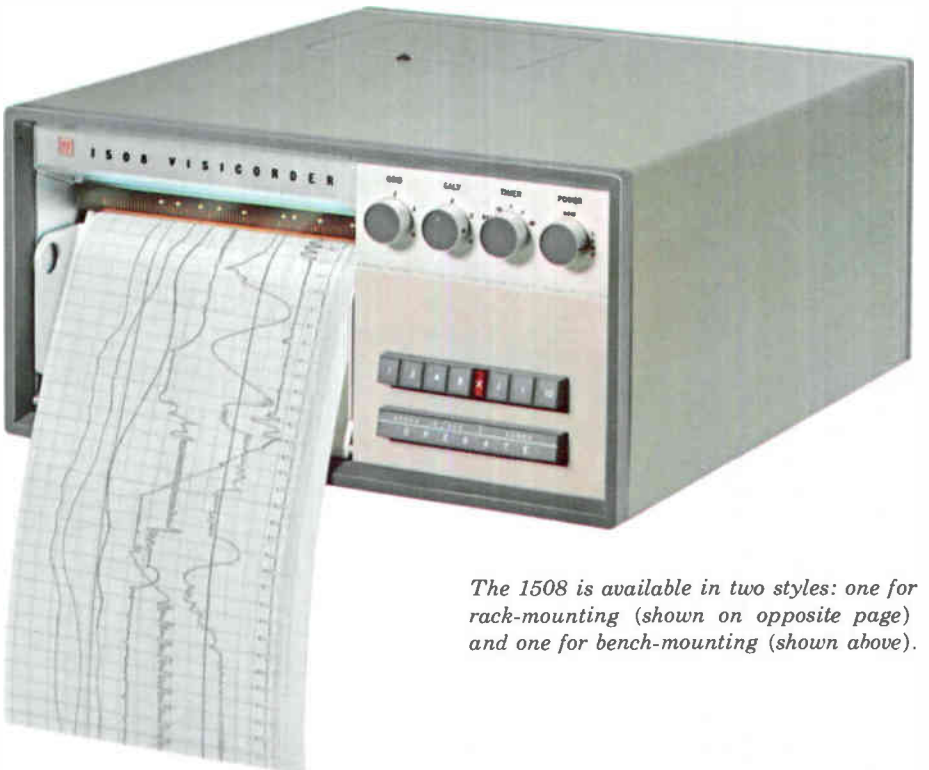
The 1508 has been designed for easy operation and service. 12 record speeds—from 0.1″ through 80″/second— are push-button selected. All controls are handy on the front panel. You can load paper in seconds. In the rack model, the cover of the 1508 stays in the rack when the instrument is pulled forward, thus providing complete accessibility for service, lamp and galvanometer adjustment. As in all Honeywell Visicorders, the actual recording spots are visible at the point of recording for precise galvanometer calibration and monitoring of information.

Solid, One-Piece Magnesium Casting

To prevent outside stresses on the instrument from introducing recording errors, the 1508 optical system, magnet assemblies, and drive system are mounted on a solid, one-piece magnesium casting.

These design refinements and extra quality features are typical of the superior instruments that have established Honeywell's leadership in the field of oscillography.

Ask your nearest Honeywell Field Engineer for a demonstration of the new 1508 Visicorder and other products described in these pages.



The 1508 is available in two styles: one for rack-mounting (shown on opposite page) and one for bench-mounting (shown above).

The loading of recording paper into the 1508 is a simple process. The roll of paper drops easily into the receptacle with no need for threading.

All operating controls on the 1508 are located conveniently on the front panel.

Condensed Specifications
Model 1508
Visicorder Oscillograph

CHANNELS: 12 or 24

GALVANOMETERS: type M, sub-miniature.

RECORD WIDTH: 8″ (actual recording width 7⅜″) with provision for narrower widths.

RECORD LENGTH: 100′ standard, 150′ extra-thin, 200′ super-thin. Unused paper indicator.

RECORD SPEEDS: 12, push-button selected, as follows: 0.1, 0.2, 0.4, 0.8, 1.0, 2.0, 4.0, 8.0, 10, 20, 40, 80″/second, changeable during operation.

FREQUENCIES: DC to 5,000 cps.

WRITING SPEEDS: greatly in excess of 50,000″/second.

TIME LINES: 4-interval system with .01, 0.1, 1.0, and 10-sec. intervals. On-off switch; provision for external synchronization.

GRID LINES: 0.1″ with 5th line heavy, or 2mm with 1 cm heavy. On-off and density control. Special scales available.

OPTICAL ARM: 11.8″ (30 cm) standard in all Honeywell Visicorders.

TRACE IDENTIFIER: 45° slope every 8″, spaced .032″ max., .02″ min.

POWER: 117v 60 cycle; 230v 50 cycle; 5-6 amps at 117v.

DIMENSIONS: 19″ wide x 7″ high x 17½″ deep excluding connectors and handles. Weight approximately 50 lb.

Other Models of Honeywell Visicorder Oscillographs

MODEL 1406...An efficient, dependable direct-recording oscillograph which makes the Visicorder principle available, on an extremely low-cost per channel basis, to users with recording requirements in the middle frequency range. Records up to 6 channels with special Type L Honeywell galvanometers.

MODEL 906C . . . with 8- or 14-channel capacity, built-in grid line and timing system, and self-starting lamp for remote operation. The built-in flash-tube timing system may be used normally or triggered externally.

MODEL 1108 . . . an intermediate 24-channel instrument which fits logically between the 14-channel 906C models and the 36-channel model 1012. The 1108 has such extra features as automatic record length control, record reverse, record numbering, push-button record speeds and time-line intervals, and integral record take-up.

MODEL 1012 . . . the ideal instrument for large-scale uses, the 1012 is the most convenient and versatile oscillograph ever built for directly recording as many as 36 channels of dynamic data. It includes all the automatic features of the Model 1108 and more besides.

USES OF THE VISICORDER

Visicorder Oscillographs are useful as direct readout units in systems for either RECORDING or MONITORING of almost any type . . . in CONTROL applications to monitor reference and error signals . . . in MISSILE and ENGINE ANALYSIS for test stand recording . . . for analog recording of TELEMETERED SIGNALS . . . in NUCLEAR TESTING to record temperatures, pressures, impacts . . . in LABORATORY work for all-purpose analyses . . . in PRODUCTION for final dynamic inspection . . . in COMPUTING for immediately-readable analog records . . . in PILOT TEST for rapid examination of prototypes . . . in ALL TESTS which are non-repetitive in sequence where oscilloscopes are impractical.

Write for further details on the new Model 1508 Visicorder Oscillograph, or call us at SKyline 6-3681, Direct Distance Dialing Code 303
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5200 E. Evans Avenue, Denver 22, Colorado

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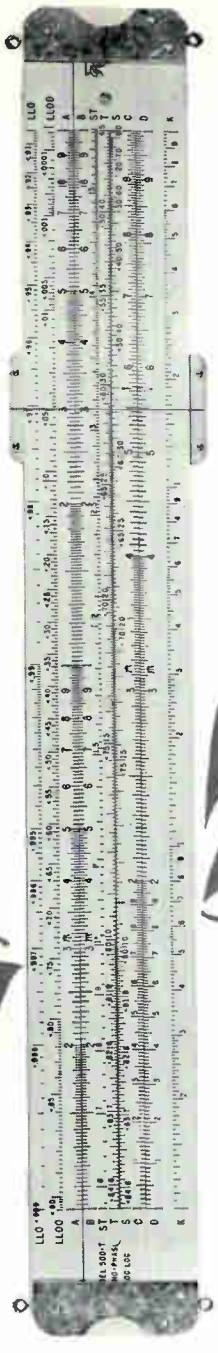

Creative minds thrive best where the climate is best

Lockheed-California Company proves this every day. For nowhere do Scientists and Engineers find a more creative, more stimulating, more academic climate.

In this environment Scientists and Engineers are encouraged to try the untried; to express new ideas; to experiment and explore. And in so doing, win recognition and reward.

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Scientists and Engineers of initiative and talent will find it worthwhile to examine immediate openings in: Aerodynamics; thermodynamics; dynamics; electronic research, servosystems; electronic systems; physics (theoretical, infrared, plasma, high energy, solid state, optics); electrical and electronic designers; structural design (wing, empennage, fuselage).

Write today to Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1511, 2408 N. Hollywood Way, Burbank, California. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin. U.S. citizenship or existing Department of Defense industrial security clearance required.

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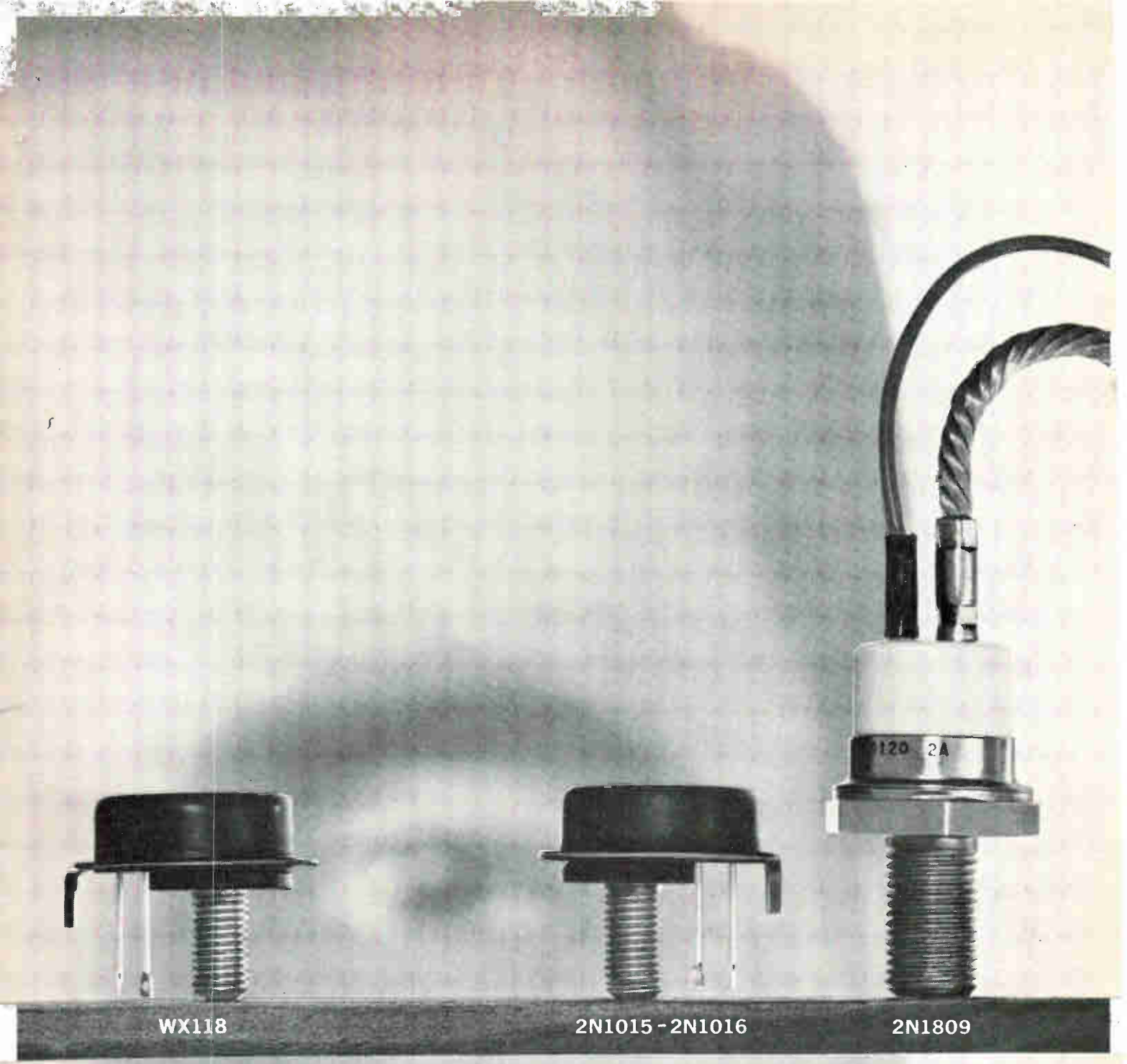
←CIRCLE 20 ON READER SERVICE CARD

CIRCLE 22 ON READER SERVICE CARD→


120 2A
WX118
2N1015 - 2N1016
2N1809

Look to Westinghouse for Silicon Power Transistors with lowest saturation resistance

2N2109

LSR*=.037 Lowest saturation resistance ratings in the industry enable design engineers to obtain three-fold increases in power-handling capability. Now—with these higher performance specifications you can replace germanium units and gain the silicon power transistor advantages of reduced heat sink size . . . higher allowable ambient . . . improved control range . . . and upgraded reliability in almost all circuits.

	I_C	V_{CE}	Typical R_{CE} (SAT)
2N1809-2N2109 series	30 A	50-200V	.037
2N1015-2N1016 series	7.5 A	30-200V	.25
WX118 series	10 A	50-150V	.22

*Lowest Saturation Resistance

2N1809-2N2109 series. New 30-amp "Rock-Top" transistors . . . world's most powerful! With 30-amp, 200-volt, 250-watt ratings these newest Westinghouse series 2N1809 and 2N2109 transistors are designed to meet the most exacting high power applications. Germanium-level saturation resistance (.037 ohms), and freedom from secondary breakdown mean highest efficiency and operating reliability.

WX118 series. World's highest gain power transistors provide current gain of 400 at 10 amps! New Westinghouse Type WX118 high-gain silicon transistors simplify circuitry, increase reliability, reduce cost of assembly. They're ideal for application in high power, high efficiency regulators, inverters and switching circuits. Saturation resistance is only 0.22 ohms.

2N1015-2N1016 series. Highest reliability from production-proved 150 watt designs. Get maximum circuit reliability at no extra cost by specifying the Westinghouse 2N1015-2N1016 series. These popular transistors have been field-proven in thousands of operating equipments. They can replace lower rated transistors (2N1489-2N1490, 2N1069-2N1070, 2N389 and others), and give you up to twice-the-power derating margin. In addition to the exclusive rating characteristics of these transistors, you get greater assurance of performance reliability from:

- **True voltage ratings.** Westinghouse transistors can be operated continuously at their full published ratings into highly inductive loads. True Voltage Ratings are verified by 100% Power Testing.
- **100% Power Testing.** Each Westinghouse transistor is 100% Power Tested before leaving the plant. Tests are conducted over the full operating range—under all conditions of base bias and collector current at maximum rated dissipation.

For more information or technical assistance, see your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Penna. *You can be sure . . . if it's Westinghouse.* SC-1054

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Westinghouse

Medical Market Growing

MEDICAL electronics market this year appears to be headed for the greatest advances yet in its short but active history. Conservative estimates of its size range between $150 million and $200 million.

Main factor in the soaring growth since January has been the introduction of commercially feasible equipment in several fields. Among these are electronic systems for hospital monitoring, pacemakers for the heart, endocardiosondes (radio pill transmitters) and associated equipment, pupillographs, phonocardiographs and electronic analgesics.

Among prototype developments are ballistocardiographs which measure cardiovascular dynamics electronically, equipment for measuring blood parameters externally, equipment using ultrasonics for tissue visualization. Also in prototype form is color tv equipment allowing retinal studies to be made at light intensities harmless to the human eye, surgical diathermy, fiber optic systems for internal body examination, ultrasonic neurosurgery and artificial muscles.

Medical electronics consumers today consist mainly of the 6,786 hospitals recognized by the American Hospital Association, 2,000 other hospitals, 3,000 related organizations (nursing homes, clinics and sanitariums), 230,000 physicians, 100,000 dentists, and a large number of research institutions and universities.

Until recently, medical instrument companies provided the technology and instruments for this market. Now, however, large companies with diversified interests are offering entire systems.

A recent marketing survey of the medical electronics industry sponsored by Sproul & Associates, Inc., New York, highlights some interesting market developments. Sales figures were received from 37 companies.

Sales Leaders

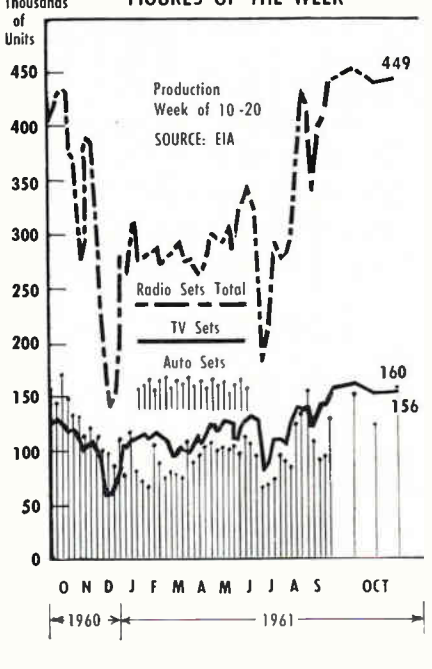
Leading in dollar volume sales among 151 types of medical electronic equipment were radioactive tracer equipment ($980,000), x-ray supplies and accessories ($540,750), dosimeters ($494,000), research and development ($275,000), stimulators ($221,250), electrocardiographs ($221,000), x-ray equipment (diagnostic $210,000, therapeutic $196,000), thermistor thermometers and controllers ($165,000), fluorometers and accessories ($150,000) and blood pressure recorders ($100,000). The large sales of radioactive-tracers is tied in with the fact that now 2,100 medical institutions and physicians have been licensed by the Atomic Energy Commission to use radioisotopes as compared with 1,500 five years ago.

Total sales for hospital monitoring systems were $30,000—according to the survey. By next June this figure may well be among the leaders. Ultrasonic diagnostic equipment, selling at $50,000, also shows future promise of greatly exceeding this figure.

Asked what they expected sales to do during the rest of 1961, 28 firms said increases could be expected and 8 feel things will stay about the same. The same question referred to 1962 got 28 increases and seven about-the-same votes; for 1965 there were 26 increase and six about-the-same votes.

Judging from the survey, medical electronic equipment is most used in research activities. Diag-

FIGURES OF THE WEEK



nostic and therapeutic applications follow in that order.

In sales procedures, 24 firms use their own staffs, while sales representatives were used by 11, laboratory supply houses by six, hospital supply houses by four and x-ray equipment manufacturers by three firms.

Importer Sees Shift In Japanese Exports

TOKYO—After surveying the market in Japan, Samuel Frankel, vice-president of American Radio Importers Association, predicts the U. S. market for Japanese electronics will be permanent and steady.

He said Japanese manufacturers —if they stress engineering and design even more—can compete with Americans in "complex" entertainment electronics. They should now look to opportunities in high-quality a-m/f-m radios, stereo and tv, he advised.

Japan, he said, squeezed itself out of the six-transistor radio market by self-imposed quotas. This opened the door to radios made in Hong Kong and Okinawa. There's no future for such radio exports, anyway, he said, because of their abundance in the U. S.

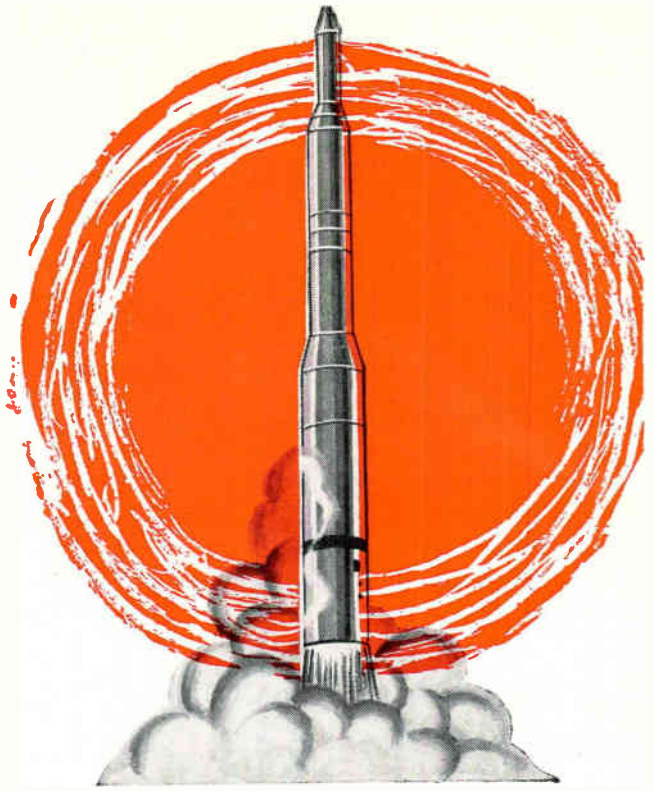
MILITARY CONTRACTING

MISSILE & ELECTRONICS
FIRST QUARTER FISCAL 1962

NAVY		
Gen Elec	$ 92,318,000	Polaris
Gen Dynamics	59,100,000	Terrier/Tartar
Raytheon	42,400,000	Sparrow II
ARMY		
Western Elec	171,821,000	Nike-Zeus
Martin Co.	120,000,000	Pershing
Kiewit & Sons	56,220,000	Minuteman (Inch
Martin Co.	51,685,000	Pershing
P. Hardeman Inc.	37,700,000	Titan II (Inch)
Eby Martin Const.	37,598,000	Launch facilitr
Sperry Rand	29,511,000	Sergeant (gse)
AIR FORCE		
Hercules Pow	50,000,000	Minuteman
Sanders Assoc	40,000,000	ASW & Anti-ms
Boeing	30,000,000	Dynasoar Gldr
Avco	28,500,000	Hgt Fndr Radar
Systems Dev	28,164,000	Sage Training
RCA	27,700,000	Dynasoar Comm.
NASA		
MIT	4,100,000	Apollo (guide)
Hughes Air	4,000,000	Syncom Satite
FAA		
Raytheon	11,578,000	ATC Radar
Servo Corp	1,734,000	DF Systems
Western Elec	1,574,000	Auto Teletype
United Air	1,000,000	Weather Comptr
Datex Corp	635,000	Weather Units

The above figures represent prime military systems awards. They are recorded for ELECTRONICS by Frost & Sullivan, Inc., of New York City, defense marketing specialists.

SELECTED BY RCA FOR A HIGH RELIABILITY * PROJECT



Here is MEASURED RELIABILITY!

Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no** failures of any type occurred*

The accumulated 22 x 10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than 00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

* *The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

** A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than ±2% and whose capacitance did not fall within the original tolerance of ±5%.
3. A part whose final dissipation factor exceeded .002 .
4. A part whose final insulation resistance measured less than 100,000 megohms.

Write for a copy of our "Reliability Study of Silvered Mica Capacitors".

El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

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• tubular paper • mylar-paper dipped • ceramic feed thrus • ceramic discs

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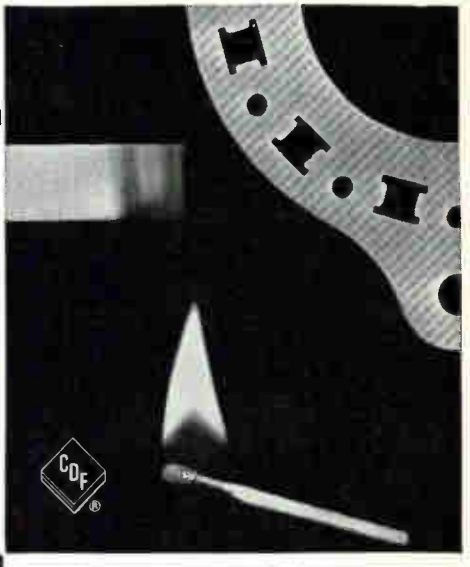
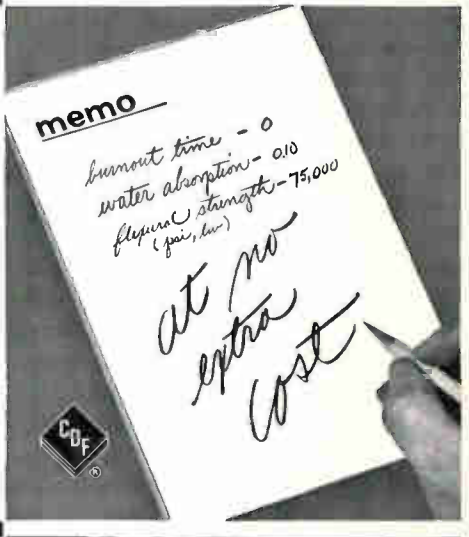
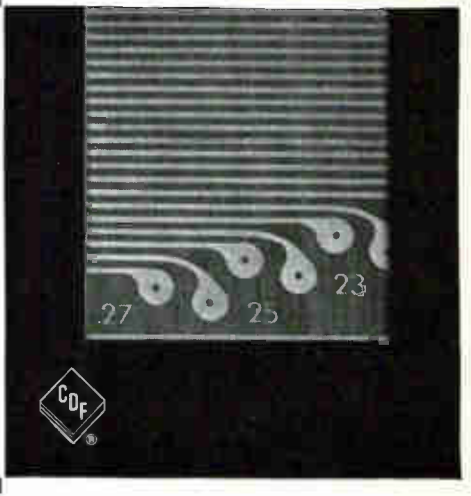
New Copper-Clad *Reliability*



In March, 1961, CDF Grade 614, glass-epoxy laminate, was announced . . . and met with almost overnight acceptance. Particular electronics and electrical manufacturers wasted no time in specifying this premium performance material with zero burnout and minimum "haloing."



By June, 1961, CDF Grade 614 had become the new standard of comparison for applications in critical ground and air-borne circuitry. Designers like its specifications, production men like the way it handles, management likes its reasonable price.



Now, CDF Grade 614 Copper-Clad is setting a new pace among particular producers of printed circuits . . . offering a new high in reliability for high packaging densities . . . and offering researchers a new tool in the investigation of molecular and submicro-circuitry.

You can take advantage of 614 Copper-Clad's unique features right now . . . in research, development or production operations. Continental-Diamond Fibre Corporation, Newark, Delaware. A Subsidiary of the Budd Company.

NOW . . . IN ONE INSTRUMENT
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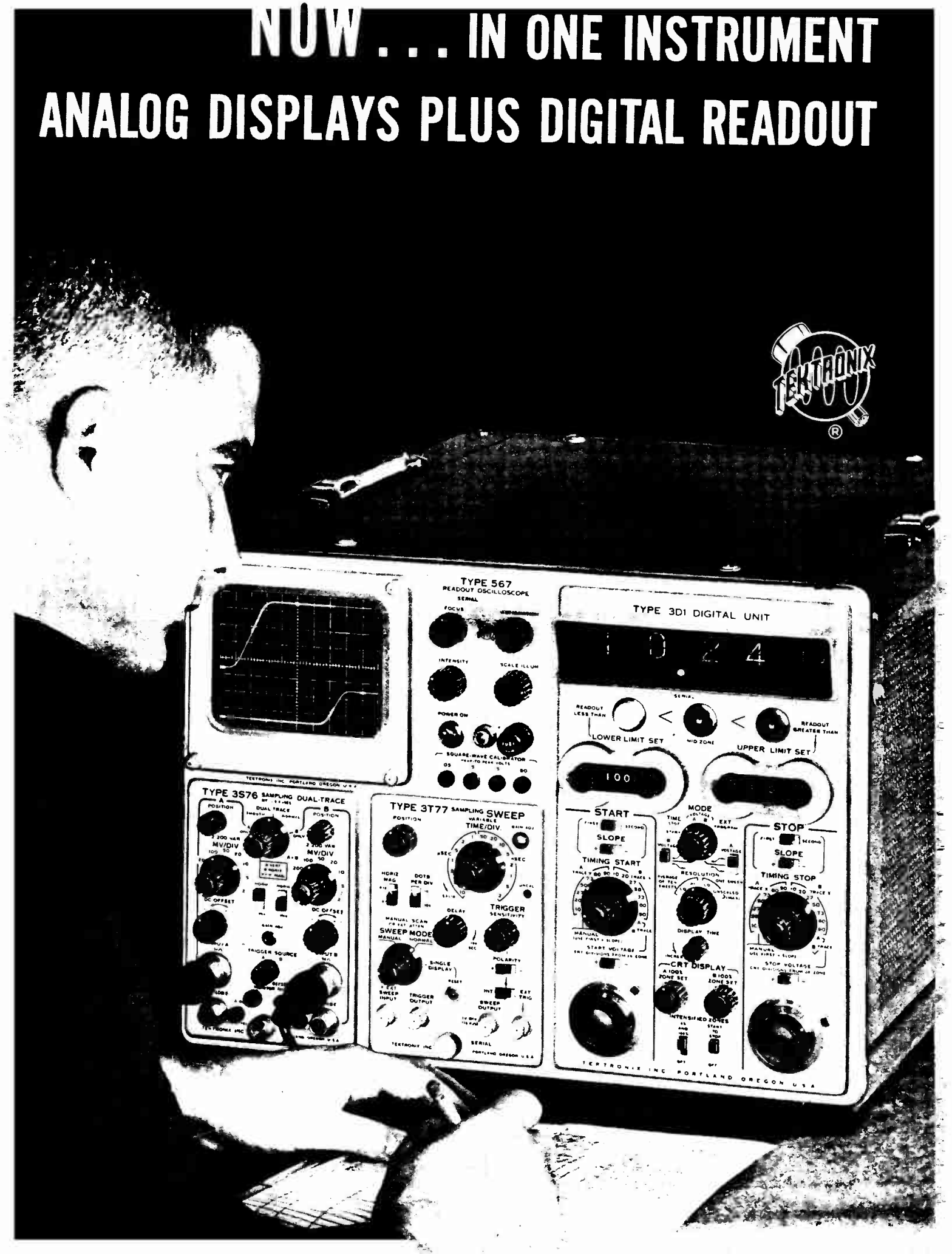

DIGITAL READOUT
of time differences to
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DIGITAL READOUT
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one-half nanosecond.

DIGITAL READOUT
of pulse amplitudes to
2 millivolts peak-to-peak.

TEKTRONIX DIGITAL READOUT OSCILLOSCOPE TYPE 567

The Tektronix Type 567 Oscilloscope adds digital readout convenience to your dual-trace applications. It presents simultaneously an analog display on the 5-inch crt with a digital presentation on the automatic computing programmer. It enables you to select and intensify the actual points—for the automatic normalization—on the crt waveforms which you wish to measure. Then you merely read directly the corresponding up-to-4-digit decimal units of actual measurement. Indicators light to designate the readout status—whether *in* the preset-limit range, *below* it, or *above* it. You set the program *once* for all successive similar measurements.

To achieve this faster and simpler approach to precision measurement, the Type 567 incorporates many features *new* to an oscilloscope. In the automatic computing programmer, for example, some of these new features include: positionable measurement-reference zones, automatic normalization, zone-intensity markers, automatic and manual start-timing and stop-timing systems, preset-limit selector and indicators, and provision for external programming. These features—and others in the two sampling plug-in units and the oscilloscope itself—enable the new Type 567 to greatly increase your measurement proficiency.

You can measure pulse amplitudes and time increments between percentages of selected amplitude levels *on an absolute or relative basis* faster and with more accuracy—especially in sustained testing programs. In addition, you can also measure pulse amplitudes and time increments on differential signals between A and B inputs.

In a typical application such as transistor-switching-time measurements, you can read directly such characteristics as the delay, rise, storage, and fall times; the total turn-on and turn-off times; the width of pulse A and pulse B; and time and amplitude between two selected points on either or both waveforms. You know immediately by the digital presentation and indicator lights whether or not the item tested has met specifications.

Type 567 Readout Oscilloscope (without plug-ins) $700
5-inch rectangular crt. 3.3-kv accelerating potential. 8-cm by 10-cm display area. Amplitude Calibrator. Edge-lighted graticule. Separate regulated heater supply. Electronically-regulated dc-supply—powers plug-in units, operates between 105-125 volts or 210-250 volts, 50 to 60 cycles.

Type 3S76 Sampling Dual-Trace Unit $1100
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Type 3T77 Sampling Sweep Unit $650
Calibrated Sweep Range—for equivalent sweep times from 0.2 nsec/div to 10 μsec/div in 15 steps, also continuously variable between steps uncalibrated, and to approximately .007 nsec/div. **10X Horizontal Magnifier. Single-Sweep Provision. 10 or 100 Samples-Per-Division. Sweep Delay Through 100 Nanoseconds. Manual Control of Scanning Function**—for XY or YT Recorders. **Internal or External Triggering**—either positive or negative, 5 mv sensitivity. (Internal 25 mv signal in *Type 3S76* results in 5 mv at *3T77*.)

Type 3D1 Digital Plug-In Unit $2500
Internal Input—from horizontal and vertical plug-in units. **In-Line Nixie*Readouts**—with up-to-4-digit decimal units of actual measurement. **Measurement-Reference Zone**—from fixed zero to 100% zone positionable over the sweep range . . . for each trace. **Automatic Normalization**—for establishing pulse amplitude or time measurements independent of dc position or pulse amplitude. **Zone-Intensity Markers**—for indicating the position of the reference zone in relation to the waveform and also the actual start-to-stop interval . . . for each trace. **Automatic Start-Timing and Stop-Timing Systems**—for controlling start and stop . . . on any of 7 calibrated % steps on either trace . . . or any combination of percentage, amplitude, polarity, first or second pulse slope or input channels A or B. **Manual Timing**—for setting the start-timing and stop-timing at selected points on the displayed waveforms. **Display-Time Control**—for varying amount of display time needed to take readings or operate associated equipment. **Preset-Limit Selector**—for setting the upper and lower limits of the readout digits. **Limit-Selector Indicators**—for designating measurements occurring *below*, *in*, or *above* the preset-limit range. **Provision for External Programming**—for sequencing automatically between various measurement programs, or for other applications.

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SEE THE TYPE 567 AND OTHER NEW TEKTRONIX INSTRUMENTS AT NEREM, BOOTHS 7 & 8

Device Designers Extend Component Ranges With Advances in Semiconductors and Tubes

Monolithic solid-state amplifiers, semiconductor delay line and wideband, high-power amplifiers are reported at meeting

By SAMUEL WEBER,
Senior Editor

WASHINGTON — Although major breakthroughs in new device development were not reported at the Electron Devices Meeting here Oct. 26-28, significant engineering improvements in solid-state technology, display devices and microwave tubes were reported.

A monolithic functional block amplifier (ELECTRONICS, p 118, Sept. 29) was described by Karl Yu and Larry Pollock, of Westinghouse. Fabricated on a single crystal silicon block, it provides transformation from high to low impedance levels with power gain over a limited frequency range.

The device—called a Unibi—consists of two active regions. The input region operates as a field effect transistor, while the output region is a conventional bipolar transistor. Both regions are processed simultaneously using photo masking techniques. Input impedance is of the order of five megohms. With the present design, the block is capable of 40-50 db power grant at current levels of 2-5 ma. Signal to noise ratio is 65 db.

Westinghouse sees the major applications for the device in audio preamplifiers, infra-red detectors, high-efficiency class-A amplifiers and as an interstage element in common base circuit configurations. A cross-section diagram of the Unibi and an experimental circuit in which it was used are illustrated.

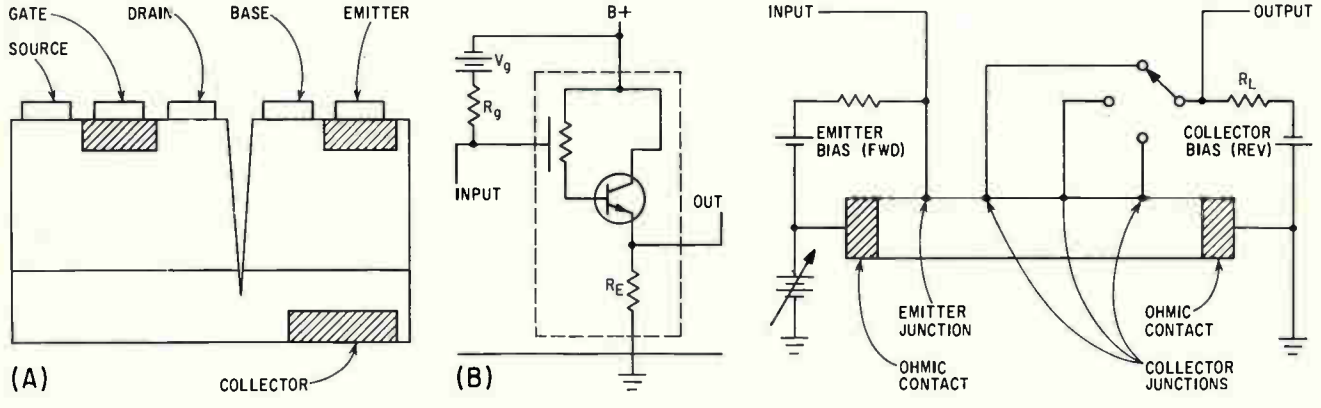
J. S. Winslow of Electro-Optical Systems Inc. reported work with a semiconductor delay line which exhibited a nearly Gaussian frequency response. Since the Gaussian response is difficult to obtain with lumped circuit elements, yet is desirable for many applications, the semiconductor delay line may fill a need in low pass filtering applications where space is at a premium.

The delay line is a germanium bar about one cm long and 0.1 cm square in cross section. An electric field is maintained by means of ohmic contacts made to the ends of the bar. An emitter junction injects minority carriers near one end of the bar and these carriers drift under the influence of the electric field toward three equally spaced collectors whose outputs feed a resistive summing network. When a periodic signal whose period is equal to the delay increment between taps is fed into the device, the output from the summary network is a maximum.

The second sketch shows the experimental setup. The delay increment can be changed by changing the electric field, hence the device is voltage tunable. In the devices made, tuning could be accomplished between 10 and 40 Kc.

In a session on storage and display tubes, General Electric's Kurt Schlesinger reported an ultra-high resolution cathode ray tube. The new microspot tube produces a spot size of eight microns permitting an information density of 3,000 lines an inch. It can scan an 8-cm square in 10,000 lines, using 42-deg deflection. This is equivalent to the display of 100 million dots on its five-inch face.

Among several new approaches to



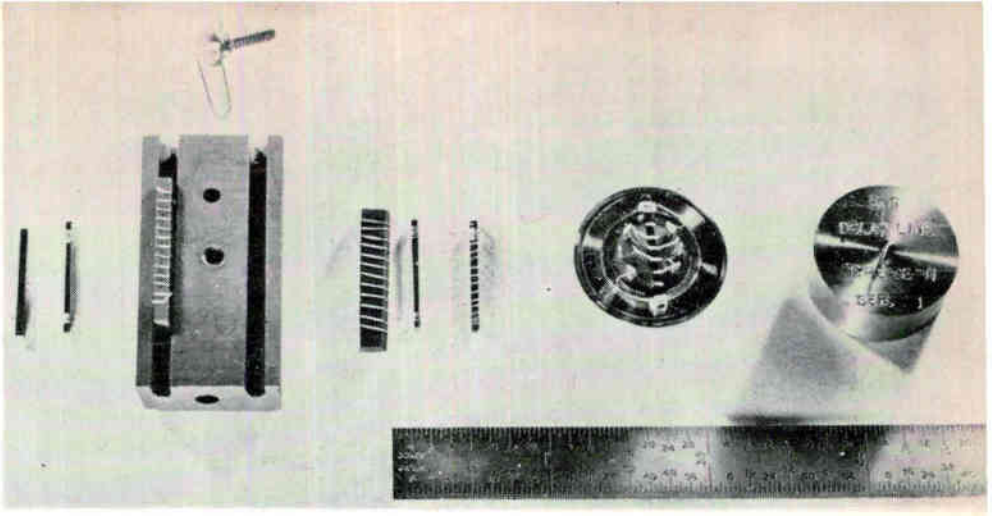
Cross-section of Unibi, a new solid-state amplifier (A) and an experimental circuit using the component (B). Frequency response that is nearly Gaussian is exhibited by semiconductor delay line (right). Here is experimental setup

electron optical design in the tube is the use of a spiral anode to double the effective length of the neck. A special microgun generates an electron focus whose brightness exceeds that at the cathode by a factor of 10.

The phosphor screen employs a thin, grainless film deposited by a vapor reaction process invented by D. Cusano, also of GE. The screen can withstand continuous loading of 30 Kw a sq cm, a common condition in the operation of this tube.

A two-color display storage tube, able to display stored information in either of two primary colors, or in intermediate hues has been developed at Hughes Aircraft Company. The tube, which has been built in the 10-in. size, can be operated with simple circuitry. It exhibits only a moderate sacrifice in resolution over its monochromatic half-tone counterpart, according to the developers, C. D. Beintema, N. J. Koda and L. S. Yaggy.

Staffers G. E. Pokorny, A. E. Kushnick and J. F. Hull, of Litton, described experiments with a new type of crossed-field microwave amplifier which they called a Dematron. To date, various developmental models of the Dematron have yielded at X-band a pulsed power output of 500 Kw, 13 db gain, 15 percent bandwidth and 35 percent efficiency. One-megawatt tubes are now being built. The Dematron design for the first time, permits gains of greater than six db in a distributed emission crossed-field amplifier without the use of the regenerative feedback of a reentrant electron beam, making significant bandwidth increases possible.



Semiconductor delay line fabrication steps: etched bar, gold wire wrapped around ends, alloying jig, graphite mandrel wrapped with aluminum wire, and delay line after alloying, mounted on header and sealed in case

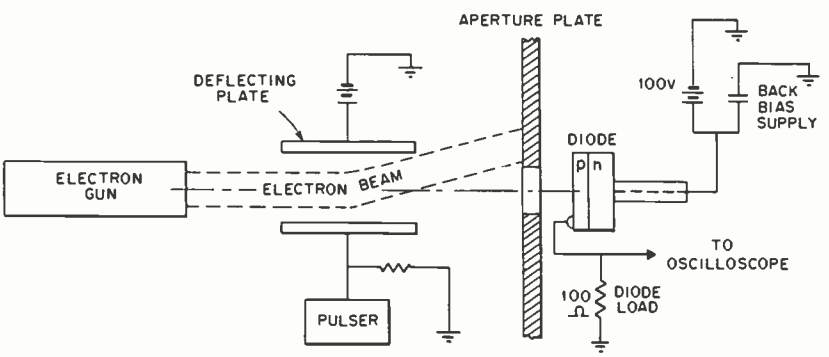
New radar power amplifier tube with a wide frequency range was described by Carl Burklund, Sperry Electron Tube division of Sperry Rand. Still under development, it is expected to improve the ability of ground defense radars to avoid enemy airborne countermeasures and jamming by permitting high-power frequency shifts.

The tube is called the Meanderline traveling wave tube because of its unusual construction (see photo). Its signal is transmitted along the surface of one or more conductors which meander the length of a two-foot row of parallel rings within the four-foot tube envelope. The electron beam travels through the rings.

Meander conductors are made of small diameter copper-plated stainless steel tubes through which liquid coolant is pumped. At present the tube has a 30 percent bandwidth, ranging from 2,550 Mc to 3,450 Mc. Further work is expected to produce frequency spreads as large as 5 Gc to 10 Gc.

Meanderline traveling wave tube gets its name from shape of tubes used to conduct signal

A. V. Brown, of IBM, reported that if electron beams are used to switch silicon diodes, output currents are higher and switching times shorter than with transistors. Experimental diodes had junctions six microns below the surface. The technique, illustrated below, may provide a high-speed, many position selector-driver for computer core memories.



Experimental setup for switching diodes with electron beam

PHYSICISTS TAKING LEAD?

Is electronic engineering a dying profession? This was somewhat wryly implied to the more than 1,000 designers attending the IRE's 1961 Electron Devices Meeting.

R. Kompfner, of Bell Telephone Laboratories, stated that all major advances in the profession are now being made by physicists rather than engineers.

Unless engineers are willing to abdicate creativity to physicists, they must keep abreast by continuous education, Kompfner said. He gave an invited paper on masers and optical masers

New England Research Cluster Grows

NEREM will draw 15,000 engineers to Boston next week, making it the industry's third largest show and reflecting area's growth

By THOMAS MAGUIRE,
New England Editor

BOSTON—The 15th Northeast Electronics Research and Engineering Meeting will be held here next week amidst evidence that New England is further strengthening its position as a principal center of electronic research—and that this role is reshaping the entire New England economy.

More than 15,000 are expected to attend the three-day NEREM, which will open Tuesday at Commonwealth Armory and the Hotel Somerset under sponsorship of the Boston, Connecticut and Western Massachusetts sections of the IRE. Since 1947, NEREM has grown from a hotel exhibit into the third largest national electronics convention.

The technical program of more than 80 papers has been organized with a view to reflecting the role of New England in the vanguard of electronics R&D.

Indicative of the area's enhanced role in research is the increasing number of decisions by non-New England companies to establish research laboratories in the area. Most recent examples are P. R. Mallory Co., Burnell & Co., Sperry-Rand and Kennecott Copper.

Laboratories Are Spur

Attracting these and other companies to the New England area are its two focal points of advanced electronics: Massachusetts Institute of Technology and the Air Force's Hanscom complex.

The Hanscom complex, core of which is the Electronic Systems Division at Hanscom Field in Bedford, Mass., has been given primary responsibility as a division of the AF Systems Command to design, develop and produce the electronic command and control systems of the future. The Hanscom complex is fast moving to the point where it will directly control the allocation of $1 billion per year in ground electronics for aerospace command and control, notably the "L" systems. Included in the Hanscom complex, in addition to ESD, are AF Cambridge Research Laboratories, MIT Lincoln Laboratory, the Rome, N. Y., Air Development Center, and Mitre Corp., the private non-profit firm which is engineering systems adviser to ESD.

Since World War II, more than 400 science-oriented enterprises have been started in the Boston area. Most are in the electronics field, and many have sprung directly from MIT labs.

Another attraction for science-based companies is the fact that there are about 30,000 degree-holding scientists and engineers in the Greater Boston area, one of the greatest concentrations in the free world.

Interdisciplinary Research

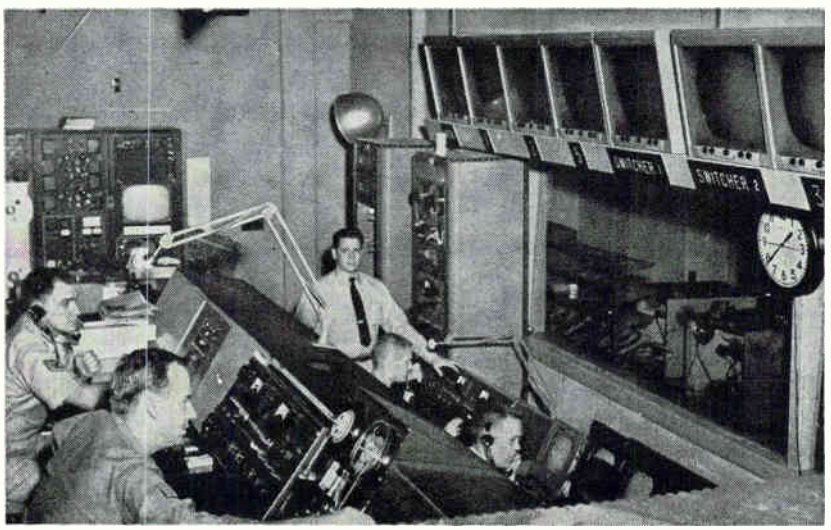
Among the most significant new developments in New England electronics—and sweeping across academic, military and commercial segments of the industry—is the emergence of interdisciplinary research as the major emphasis.

Already organized at MIT are the new centers cutting across traditional departments: the Centers of Materials Science and Engineering, Communication Sciences, Life Sciences, Earth Sciences, and Aeronautics and Astronautics.

Analogously, the staffs of the Electronics Research Directorate and the Geophysics Research Directorate at Hanscom Field have been merged into the AF Cambridge Research Laboratories. "The classical demarcation between these two research areas over the past decade has become increasingly blurred," says Brig. Gen. B. G. Holtzman, commander of AFCRL.

Decision of the world's largest copper producer, Kennecott Copper

Tv Helps Train Air Officers



Control room of closed circuit tv system installed by RCA at Air University, Maxwell AFB, Ala., feeds live, film, tape or off-air programs to 165 viewing locations. Auxiliary communications allows students in classrooms to ask questions of lecturer

Corp., to set up a research lab on Massachusetts Route 128 emphasizes the interdisciplinary trend in industry also. The new laboratory will conduct basic research emphasizing solid-state physics of metals. Director will be Ewan W. Fletcher, formerly associate professor of electrical engineering at MIT.

Fletcher recently expressed the goal of "searching for basic relations between electronic, atomic and molecular structure . . . in the form of physical, mechanical, electrical, magnetic and thermal properties of materials.

"We shall cooperate with academic, governmental and industrial groups on an international scale to contribute to the generation of an interdisciplinary materials science which will undoubtedly evolve in the present decade."

Nearly 400 Exhibits

NEREM exhibits at Commonwealth Armory next week will number nearly 400 and will highlight technical advances principally.

Keynote address, "New Directions in Electronics Research", will be given on the opening day by John L. Burns, president of RCA. Also at this formal opening ceremony, Dr. Burns will be honored by Eta Kappa Nu, electrical engineering honor society.

At the NEREM banquet Wednesday night, Charles H. Townes, newly named provost of MIT, will speak on: "Optical Masers: Past, Present, Future and Imaginary".

The NEREM Record will be available on opening day and will include illustrated digests of all technical papers.

New Registration Card

A new registration and product inquiry card will be tried out at NEREM '61. Called Reg-Ident, the plastic "credit card" has been obtained in advance by many NEREM visitors. It is designed to increase speed and efficiency of registration and also simplify the distribution of product literature.

Each NEREM exhibitor will have one or more imprinters to register product inquiries. Using Reg-Ident, either the exhibitor or the visitor can register the inquiry. System will eliminate need for spectators to carry quantities of literature from the show.

Executive Pay Reaches

By A. B. NICHOLS, III,
McKinsey & Co., Inc.,
Management Consultants,
New York, N. Y.

INCOME for chief executives in the electronics industry rose three percent last year as industry sales reached new highs. Although this increase is modest, it was granted in a year when top management pay in industry as a whole was unchanged from 1959.

This information was developed from a survey of top executive pay in 585 American companies listed on the New York Stock Exchange. For purposes of the study, these companies were grouped into 25 major industries to provide a broad picture of top executive compensation.

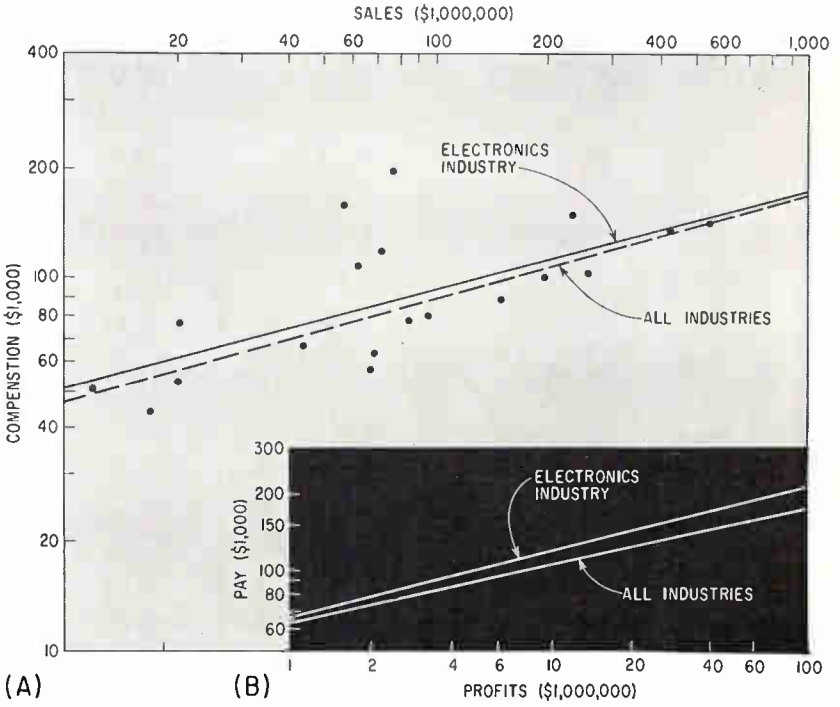
This survey has consistently shown that the pay of chief executives is closely tied to the level of sales and profits achieved by their companies. This industry-wide compensation relationship also holds true for the electronics industry, as shown by the closely parallel lines on the accompanying chart.

Chief executives of electronics firms are paid slightly more than their counterparts in industry generally. This differential may be a measure of the risks involved in managing a small company in the rapidly changing electronics industry. For example, an electronics company with sales of $10 million paid its chief executive about $5,000 more per year than the average paid by industry generally. However, as the electronics company grows and achieves greater stability in the markets, this pay advantage gradually disappears.

Profits Affect Pay

Profits tell a somewhat different story. The electronics chief executive earns more than his counterparts in industry generally who produce the same profit figure.

Top electronics executives increasingly out-earn other executives as profits grow. This is not surprising in view of the dynamic nature of the industry. It emphasizes that unusually competent ex-



Pay of executives in electronics companies is better than compensation in industry in general, both as percentage of sales (A) and as percentage of profits (B) dots represent actual compensation

New High

EXECUTIVE PAY AS PERCENT OF CHIEF EXCUTIVE'S COMPENSATION

	2nd	3rd	4th
Air transport	65%	59%	57%
Aircraft and missiles	79	62	53
Automotive	71	66	62
Building materials	66	56	49
Business machines	70	53	50
Chemicals	71	63	59
Consumer durables	79	64	61
Department stores	76	70	63
Electrical equipment	67	56	50
Electronics	79	63	59
Foods	71	72	61
Food and drug chains	76	61	54
Industrial metal products	68	55	47
Large diversified companies	76	68	63
Machinery (nonelectric)	69	58	56
Nonferrous metals	69	57	50
Paper	82	66	59
Petroleum	73	62	50
Public utilities	71	55	45
Railroads	60	50	49
Rubber	75	56	46
Soaps, cosmetics, pharm	74	59	51
Steel	95	56	49
Textiles	77	63	59
Tobacco	78	61	55
All Industries	73	61	51

ecutives are needed to produce profits in electronic companies.

The sensitivity of chief executive pay to company profits shows clearly in company practice within the electronics industry. Over half of the companies studied paid their chief executives the same or less than in 1959. Most of these companies suffered a decline in profits or earned the same as in the year before.

In the more stable industries, top level pay is relatively insensitive to profit shifts. For example, electrical equipment chief executives received a two percent increase in compensation in 1960, while profits actually declined 14 percent.

Pension Pay Low

Data on pension plans suggests that electronics chief executives may have somewhat smaller post-retirement earnings than chief executives in industry as a whole. While 78 percent of electronics companies surveyed have pension plans for top executives, industry generally reports 87 percent. Furthermore, electronics companies estimated annual pension was 17 percent of 1960 chief executive compensation—the lowest level among all industries surveyed. Public utilities chief executives topped the list with pensions averaging 33 percent of recent compensation.

To round out the picture of ex-

ecutive compensation in the electronics industry, the study was extended to include the second, third, and fourth highest paid men in each company. Expressing their pay as a percentage of chief executive compensation discloses that these executives are above the number two, number three, and number four men for all industry. For example, the second highest paid executives among electronics companies averaged 79 percent of the top man's compensation, as against 73 percent average for the number two men in industry as a whole.

Those electronics executives just below the chief executive are closing the pay gap on the boss. Again taking the number two executives as an example, they received pay increases approximating 12 percent over 1959, while chief executives received only three percent. Apparently the pay of next-in-line electronics executives continued to rise in line with increases in sales volume.

Yet top electronics executives fared well compared with chief executives throughout industry. Only three of the 25 industries studied increased the compensation of their top men by more than three percent, and in 14 out of the 25 industries, chief executive pay was actually lower than in 1959. Chief executives in the tobacco industry took a seven percent pay set back. The big gainers were chief executives in air transport, who averaged nine percent above 1959 compensation.

Another Orthicon Made

Toshiba reports it will be making about 100 a year of 4.5-inch image orthicons for tv tape recording. This size tube is also being made by RCA and the English Electric Valve Co.

Computer Controls Rocket Testing

ON-LINE automatic data acquisition system and computer complex (Adacc) is used at the Naval Propellant Plant, Indian Head, Md. to step up pilot production of more efficient fuels for motors used in Polaris and other missiles.

Test is watched in blockhouse

To date, over 300 firings have been completed with the system. Capt. Otis A. Wesche, commanding officer, says the system has increased production 20 to 25 percent. In addition to on-line analysis of motor characteristics, the system helps prevent costly motor blowups.

Adacc was designed primarily for static firings. It includes a $400,000 data system, built by Interstate Electronics Corp., and a rented RCA 501 computer. System costs can be recaptured in a year by savings.

The acquisition system consists of an analog section feeding the computer through a digital assembly and adapter unit. The computer can work on other programs up to test time. After the motor fires and is analyzed—about three minutes—the program is resumed.

Any of 128 previously calibrated transducers can be selected for a test. Calibrations stored on tape are selected at time of interruption according to preset identification words on the console. ID words are transmitted with data to the computer. Errors arising during transmittal can be corrected by an off-line program. The computer checks firing conditions every 6 msec.

The Navy plans to expand Adacc programs until practically all large scale firings are handled.

ELECTRON TUBE NEWS from SYLVANIA

Recording data on film with fiber optic CRT.

- **30 times increased light output**
- **improved image resolution**

NEW! FIBER OPTIC CRT's!

At Sylvania, the amazing phenomenon of optical fibers is revolutionizing resolution capabilities of cathode ray tubes. These tiny light pipes, transparent dielectric cylinders only 10 microns in diameter, conduct light from the phosphor screen to the outside surface of the CRT face. This dramatic new technique completely eliminates parallax. Used in photo-recording applications, it eliminates lens requirements, enables direct photoprinting.

Now available for sampling are: 5" diameter CRT's with faceplates composed entirely of optical fibers or with a .250" x 4.125" array of optical fibers for linear scanning; a rectangular 3" x 1½" CRT featuring a .250" x 2.750" array of fiber optics. These remarkable tubes can be supplied with either electrostatic or magnetic deflection and focus and with aluminized or nonaluminized P11 or P16 screens.

Currently under development are fiber optic CRT's capable of magnifying images and of coding signals by "scrambling" light transmission.

If your project calls for exceptionally high resolution in photo recording, flying spot scanning, mapping or reconnaissance systems, these extraordinary developments deserve your careful examination. Ask your Sylvania Sales Engineer for complete information.

NEW from SYLVANIA!

3-Gun Spiral Accelerator

for multiple tracking radar

Sylvania SC-3090 is a high-precision instrument with a 5½" square face. Its tri-gun structure is so accurately designed and aligned it provides a tracking error of less than .055" at any point on the tube face. Electrostatically deflected and focused, it offers high deflection sensitivity, high resolution and writing speed, minimal pattern distortion. SC-3090 is available with aluminized screen and P19 phosphor.

Single-gun Spiral Accelerators, 5BGP/T51, 5BHP/T54, are available with a new brighter phosphor and "Bonded Shield" safety cap for increased image readability. Assembled on Sylvania-developed mounting jigs to exceptionally close tolerances, they provide superlative precision performance.

Absolute Max. Ratings	SC-3090	5BGP—	5BHP—	Units
Anode #3 Voltage	10,500	13,200	13,200	Vdc
Isolation Shield Voltage	3,500	2,300	2,300	Vdc
Deflection Plate Shield Voltage			2,300	Vdc
Anode #2 Voltage	3,500	2,200	2,200	Vdc
Anode #1 Voltage	1,750	880	880	Vdc

Low drain heater-cathode design for battery-powered applications . . .

Now in 3 CRT families!

Typical of continuing Sylvania advancements in the "state of the art" is the remarkably efficient heater-cathode assembly employed in Sylvania-3BGP—, 3BMP—, SC-3016. With a rating of 1.5V @ 140mA, it consumes only 0.2 watts and enables battery life of 400 hours from a #6 dry cell operating up to 2 hours daily. Further, it possesses extremely low mass (0.05" dia., 0.011" thick), thereby enhancing resistance to shock and vibration, so vital for reliable, portable operation. Significantly, this unusual development is adaptable to virtually any existing CRT design.

Key Characteristics	3BGP—	3BMP—	SC-3016	Units
Anode #3 Voltage		6600*		Vdc
Anode #2 Voltage	2750*	2200*	2750*	Vdc
Anode #1 Voltage	1100*	1500*	1100*	Vdc
Face Dimension	1½x3	3	1⅛	Inches
Over-All Length	9¼	10	6	Inches

*Absolute maximum ratings

Low grid drive! Low current heater!

Sylvania-10ANP for radar display

Sylvania-10ANP is ideally suited to compact radar equipment. Here's why: small yoke for increased sensitivity, low grid voltage requirements and 300mA heater enable excellent performance from transistorized power supplies; further, it features small, 0.840" diameter neck, short over-all length of only 16" and 9-pin miniature base.

Sylvania-10ANP offers magnetic deflection and focus, aluminized screen and a wide range of phosphors. Currently under development at Sylvania are 5", 7" and 12" versions of the 10ANP.

If your design demands specialized cathode ray tubes, call on the high quality-quantity capabilities of Sylvania. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

NEEDED NOW:

Radiation-Resistant Components!

Few reliability studies hold such great import for national security as those investigating radiation effects on electronic components. Will, for example, electronic components withstand continuous radiation from the reactor of a nuclear-powered craft?

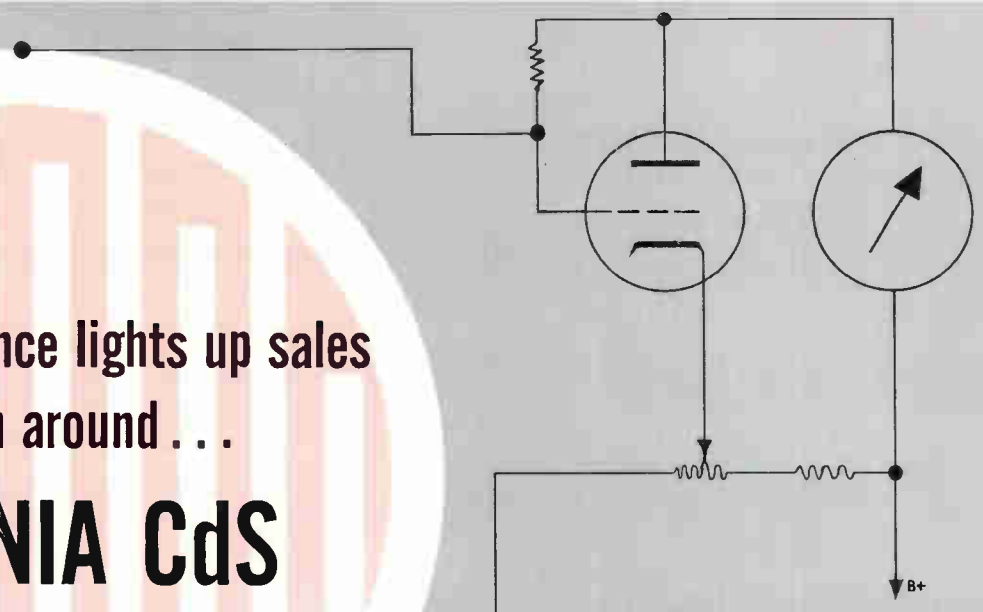
Intense radiation is known to have disastrous effects on solid-state performance. How, then, do you design for reliable, compact circuitry without imposing prohibitive weight penalties of massive shielding?

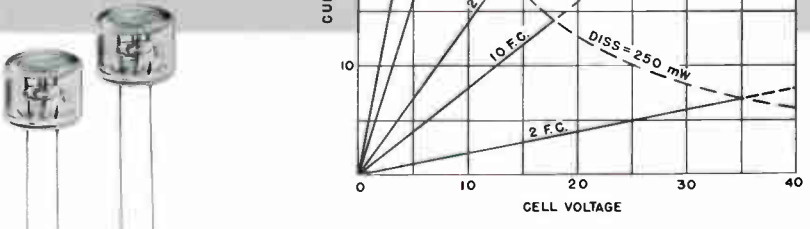
One good way: design around radiation-resistant Sylvania Gold Brand Subminiature Vacuum Tubes. All Gold Brand Subminiature types are rated for steady state radiation resistance. Extensive testing prove them capable of withstanding 10^{12} neutrons/sq. cm./sec. dose rate for a total dosage of 10^{16} neutrons/sq. cm. Further, Gold Brand Subminiature Tubes tolerate pulses of pure gamma radiation of approximately 10^{6} R./sec. Compare this with the gamma dose rate of 0.1 R./sec. absorbed ¾ mile from a 20KT bomb—it's well within the operating capability of Gold Brand Subminiature Tubes.

Vacuum tubes are compatible not only with nuclear environments but extreme shock and excessive temperatures. Extended periods of storage, too, have little or no effect on vacuum tubes. Ask your Sylvania Sales Engineer for complete information on the many remarkable capabilities of electronic tubes. He can supply you with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

bright performance lights up sales when you design around . . .

SYLVANIA CdS Photoconductors





Sylvania-8100 is the first of a new family of Cadmium Sulfide photoconductive devices for industrial-commercial light-actuated control applications. Proven in self-adjusting TV brightness and contrast controls, Sylvania-8100 features two foot-candle resistance of 5000 Ohms and a minimum dark resistance of 200,000 Ohms.

Sealed-in-glass techniques provide a moisture-resistant device, protect wafer, assure long, reliable life.

Blue Dot Protection on light-sensitive wafer indicates device is vacuum-tight. If the unusual occurs and a leak develops, blue dot turns to pink . . . a special confidence feature on all Sylvania photoconductors.

Hydrogen-Filled after thorough evacuation; improves dissipation characteristics, enhances stability and uniformity.

Automated Techniques provide excellent control of physical characteristics such as the configuration of electrodes on the CdS wafer, assure superior characteristics of uniformity.

If your design area includes lighting, sorting, door controls, headlight dimmers, data processing, fire or smoke detection or similar work, contact your Sylvania Sales Engineer. He will give you complete information on this and other photoconductors under development at Sylvania. For technical data on Sylvania-8100, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

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MEETINGS AHEAD

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, Mass., Nov. 13-14.

MAGNESIUM & MAGNETIC MATERIALS, IRE, AIEE, AIP, ONR, AIME; Westward Ho Hotel, Phoenix, Ariz., Nov. 13-18.

MATERIALS AND DESIGN Exhibition Conf., Earls Ct., London, Nov. 13-18.

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

NEREM, Northeast Research & Engineering Meeting, Commonwealth Armory and Somerset Hotel, Boston, Mass., Nov. 15-17.

AEROSPACE ELECTRICAL SOCIETY, Pan Pacific Auditorium, Los Angeles, California, Nov. 15-17.

ELECTRICAL MANUFACTURERS, National Assoc., Annual, Plaza Hotel, New York City, Nov. 16.

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

JOINT COMPUTER CONFERENCE, Eastern, PGEC of IRE, AIEE, ACM; Sheraton-Park Hotel, Washington, D.C., Dec. 12-14.

RELIABILITY AND QUALITY CONTROL, 8th National Symposium, PRGQC of IRE, AIEE, ASQC, EIA; Statler Hilton Hotel, Washington, D.C., Jan. 9-11.

MILITARY ELECTRONICS, 3rd Winter Convention PGMIL of IRE (L. A. Section); Ambassador Hotel, Los Angeles, Cailf., Feb. 7-9.

SOLID STATE CIRCUITS, International Conference, PGCT of IRE, AIEE; Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa., Feb. 14-16.

SWITCHING THEORY, Application to Space Technology Symp., USAF, Lockheed Missiles & Space; Lockheed, Sunnyvale, Calif., Feb. 27-Mar. 1.

SCINTILLATION AND SEMICONDUCTOR Counter Symp. PGNS of IRE, AIEE, AEC, NBS; Shoreham Hotel, Washington, D. C., Mar. 1-3.

IRE INTERNATIONAL CONVENTION, Coliseum & Waldorf Astoria Hotel, New York City, Mar. 26-29.

SOUTHWEST CONFERENCE AND SHOW; Rice Hotel, Houston, Tex., April 11-13.

JOINT COMPUTER CONFERENCE, PGEC of IRE, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3.

Only 1-1/2 ounces (including the switch plate)

Heinemann's new Series VP may well be the lightest circuit breaker made. For sure, it's one of the smallest and most compact you'll find around. Yet, remarkably, it's capable of handling all the functions of much larger Heinemann breakers.

It is temperature-stable. Current rating and calibrated trip-points are completely unaffected by ambient temperature. No derating . . . ever.

It is available with a choice of time relays. You can have either a "fast" or "slow" delay. Or instantaneous response.

It can be furnished with any of Heinemann's special-function internal circuits. With a little ingenuity and a special circuit, you can make the breaker do such out-of-the-ordinary chores as remote switching, circuit "slaving," alarm signaling.

The matchbox-size Series VP is available in any integral or fractional rating you might need, from 0.050 to 15 amps (at 110V, 60 or 400 cycles AC, or 50V DC).

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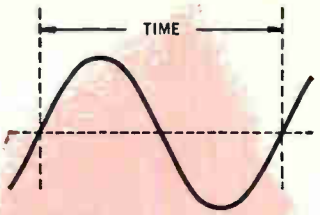
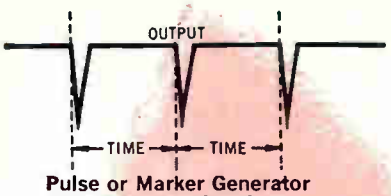
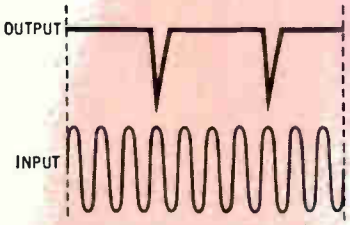


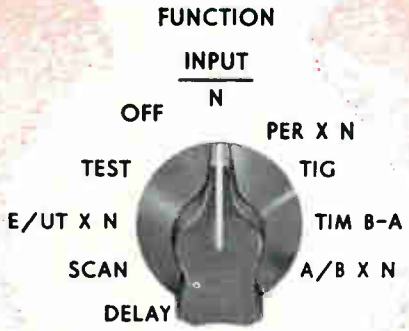
Period Measurements
from 0.000001 cps in 1 μsec units.

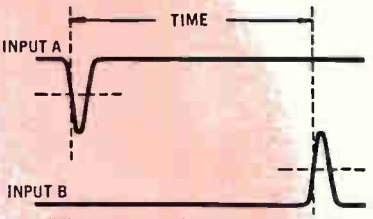


Pulse or Marker Generator
from 0.1 ms to 9.999 sec.

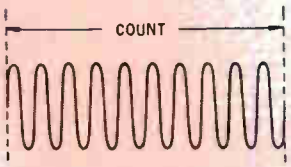


Preset Counter-Controller
from 1 to 9999 events.

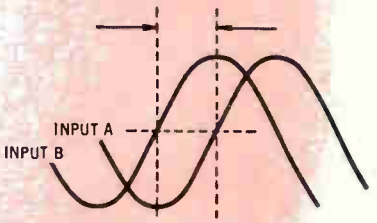




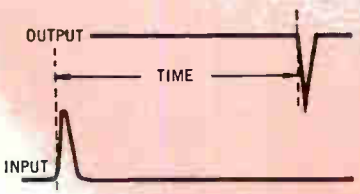
Time Interval Measurements
with 1μsec resolution.



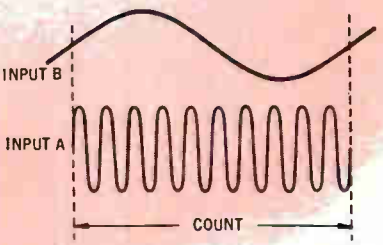
Frequency Measurements
to 1 Mc.



Phase Difference Measurements
in degrees or μsec.



Time Delay Generator
from 0.1 ms to 9.999 sec.



Frequency Ratio Measurements
1 to 9999.

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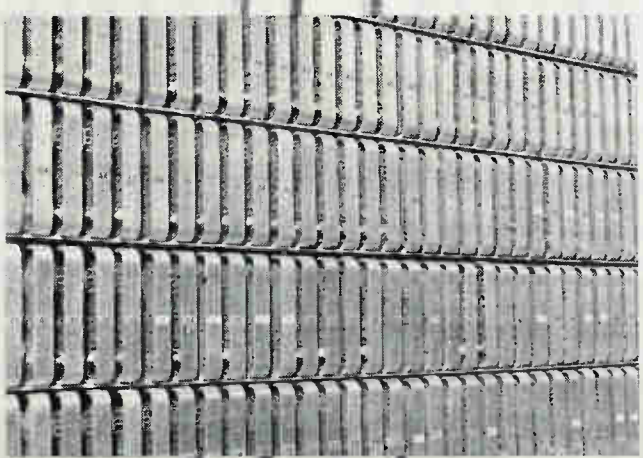

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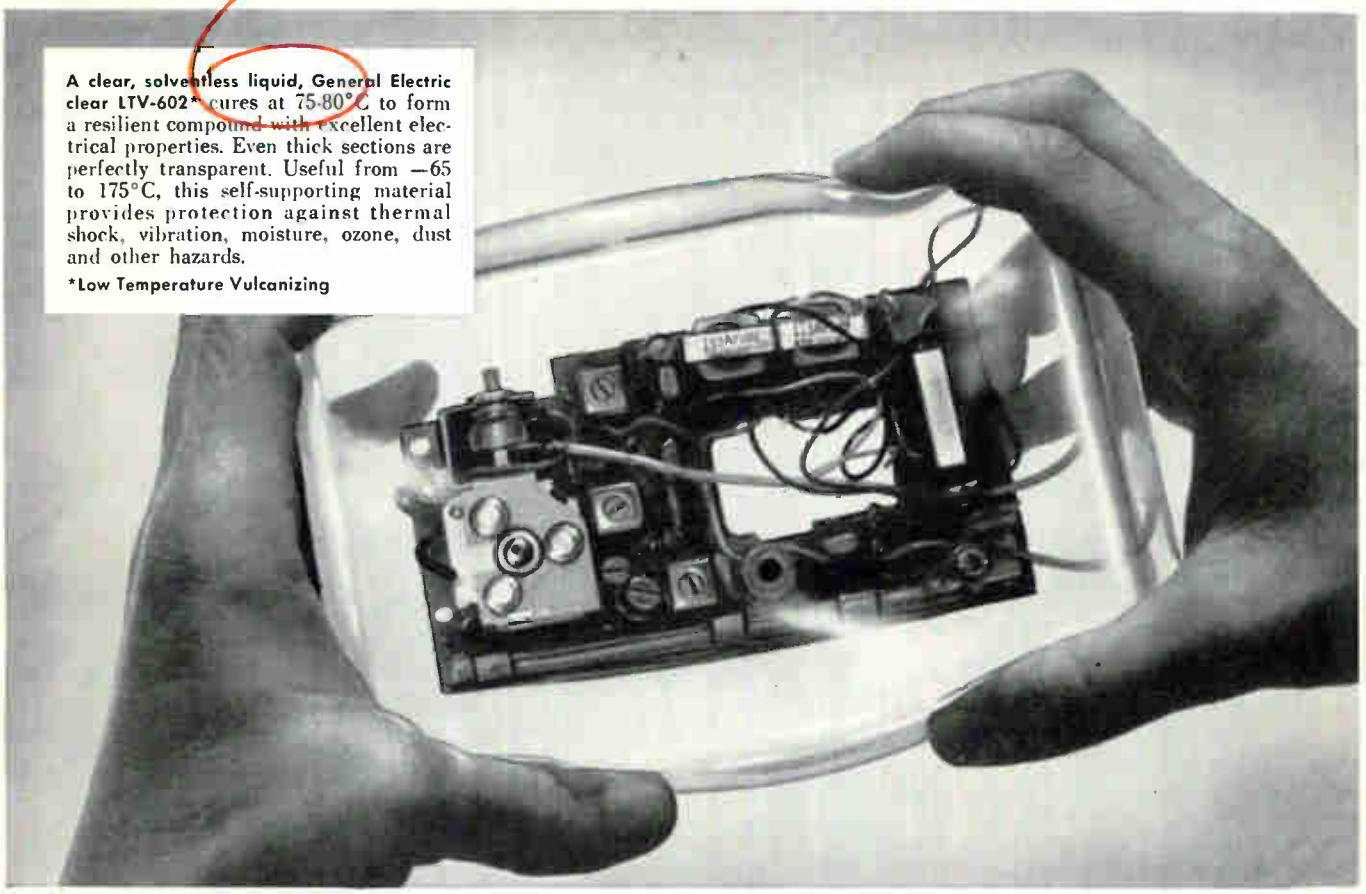
(OR 2 HOURS WITH HEAT)



A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from —65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

***Low Temperature Vulcanizing**

General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair

LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a flexible solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.

LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material. repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.

Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

NOW CURES IN 2 HOURS — CAN EVEN USE HEAT LAMP!

3 TIMES FASTER THAN BEFORE

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information write to General Electric Company, Silicone Products Department, Section N1163, Waterford, New York.

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VT2	VT4	TV8	VT20
1.5-1.8 amp	3.5-4.75 amp	7.5-10 amp	20 amp

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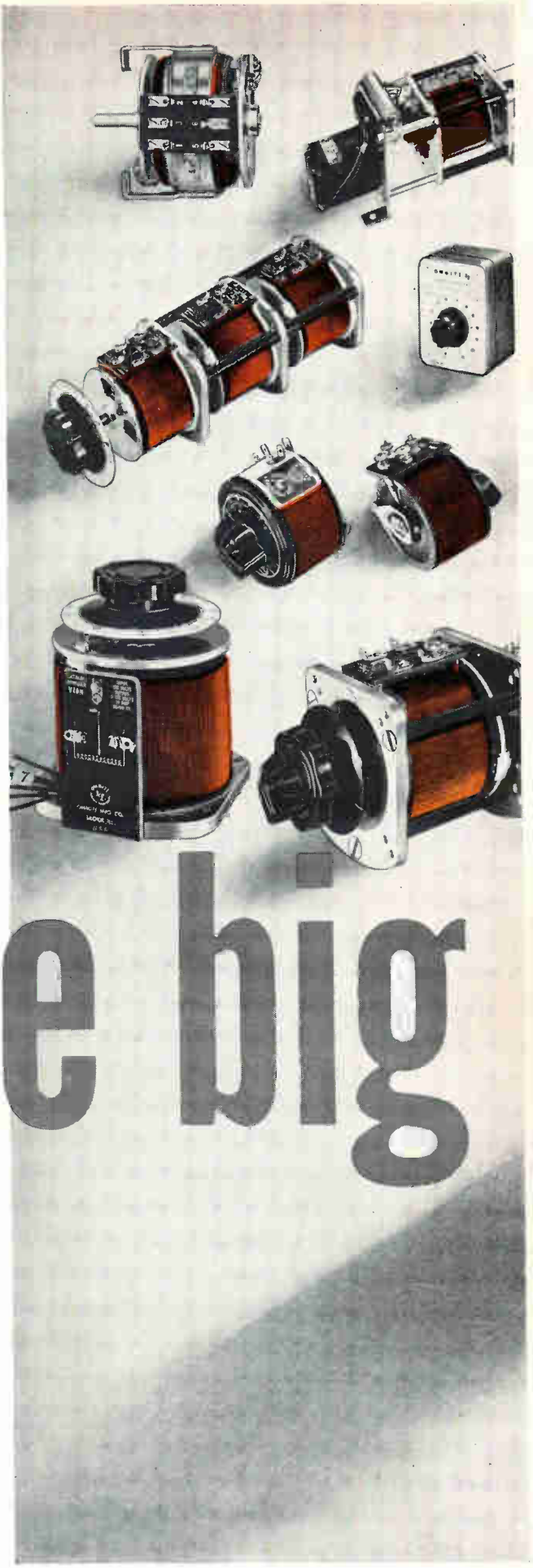
- Pick 36V transformers in 5-, 12-, or 22-amp ratings for your transistorized circuits.



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From every aspect, you'll find that Ohmite is a good place to purchase variable transformers. If you need a "special" . . . okay, just tell Ohmite. Need some engineering assistance? All right! What about quantity? Ohmite can handle big orders, medium, and small. The Ohmite VT line of variable transformers is broad and deep. So is the service. Find out by specifying "Ohmite" on your next requirement for variable transformers.

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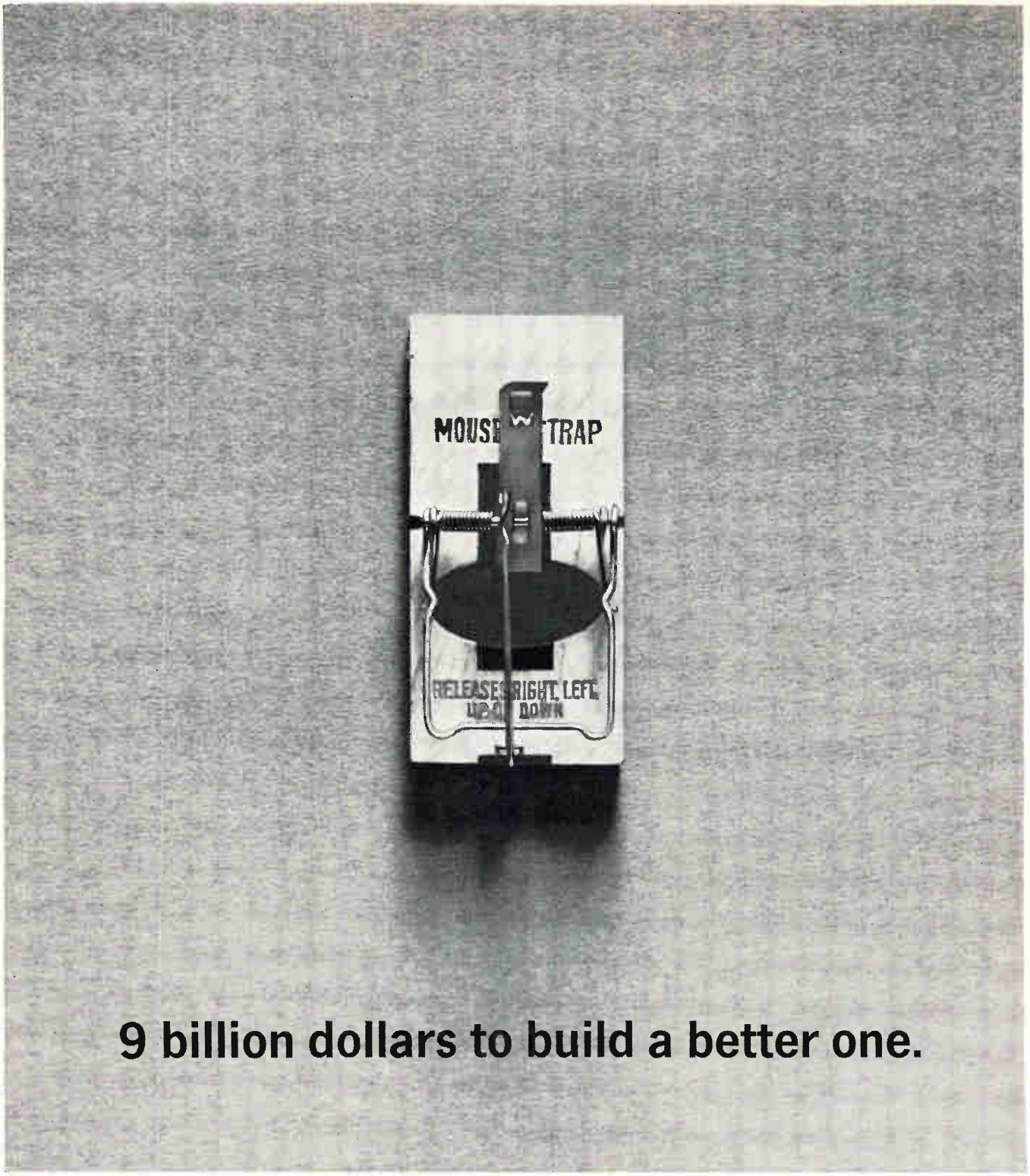

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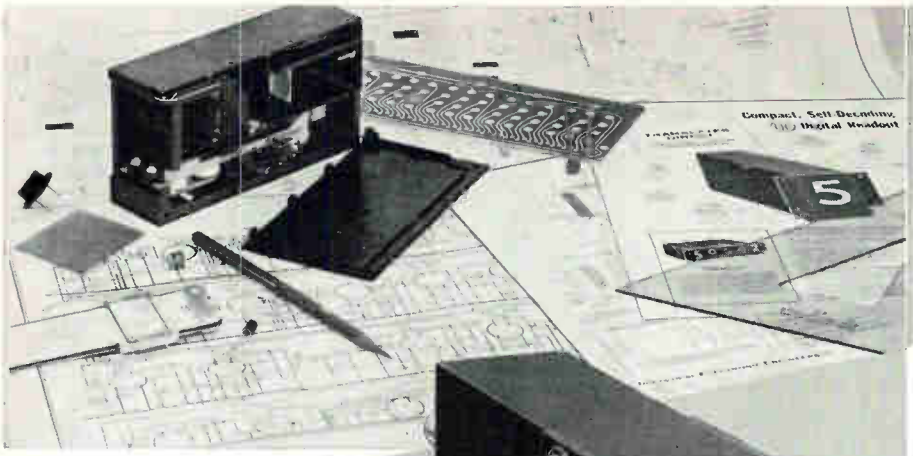

NEW BINARY DECODING DIGITAL READOUT

BINA-VIEW

Now, with the new Bina-View, digital readouts take on an added dimension. Here is a readout that operates direct from binary input, has its own retentive memory, and offers one-plane in-line presentation. Realistically priced and designed with the user in mind, it is not to be confused with other readout devices on the market. The Bina-View Digital Readout fills the long-standing need for a fast, accurate, binary operated display in the fields of digital computers, missile checkout systems, ground support equipment, etc. Its ability to operate within a wide range of binary codes makes it the most versatile readout available today.

Translates Direct—Coded Binary-to-Decimal and Alpha-numeric

Self-Decoding. The new Bina-View Digital Readout accepts any BCD or teletype code up to six bits, does its own translating, and displays the proper character. There are no auxiliary translators, relays, or diodes required.

Low Power. The Bina-View Digital Readout may be operated with as little as ten milliwatts per bit of signal power. It may be connected directly into computers and other electronic equipment.

Character Storage. The Bina-View Digital Readout will continue to display the last character entered after the signal-input power has been removed.

Memory and Verification (Optional). When required, contact closures may be provided for verification that the input signals have been properly accepted.

Practical. The Bina-View Digital Readout offers clear distinct characters, high even brightness, and wide viewing angle. Extremely durable and vibration-free, it is designed for thousands of hours of trouble-free operation.

Prices start at $50.00 each

Available in individual units or assemblies. Write today for complete detailed specifications.

Representatives in principal cities.

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
Engineers & Manufacturers of Fully Automatic Systems & Digital Readouts
5528 Vineland Avenue, North Hollywood, California

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choose NICAD®

NEW Nickel Cadmium Rechargeable Batteries

SEALED CELLS

Hermetically sealed and rechargeable, Nicad batteries are small in size, require no maintenance, operate in any position. They make practical the battery operation of many types of equipment not previously suited to dry, mercury, or lead acid types.

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High surge power cells, in sintered or pocket plate types, are capable of sustained voltage at high discharge rates over a wide temperature range. They have extremely long life . . . little or no maintenance. For more of the POWER story, write

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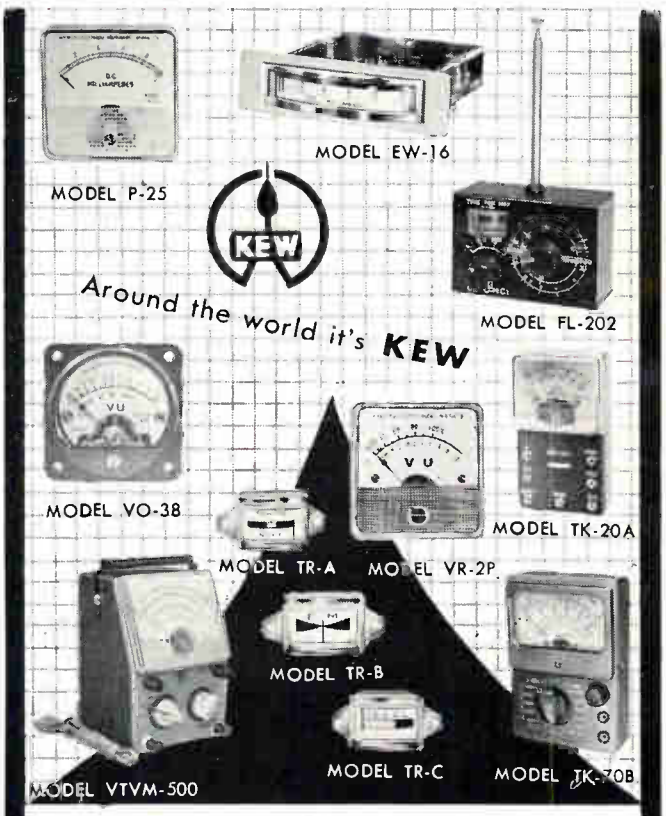

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Cable Address: "KYORITSUKEIKI TOKYO"
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ANNOUNCING THE FAIRCHILD FD600

PLANAR

for surface protection and reliability

EPITAXIAL

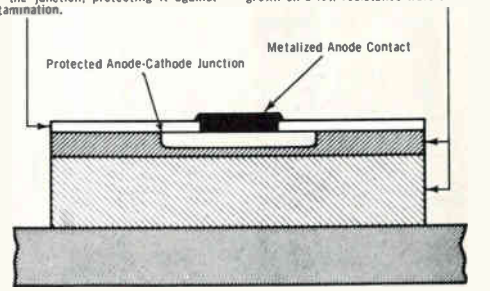
for high speed, high conductance

DIODES

FAIRCHILD PLANAR EPITAXIAL DIODE STRUCTURE

PLANAR CONSTRUCTION features an integral passivated surface of silicon oxide over the junction, protecting it against contamination.

EPITAXIAL CONSTRUCTION consists of a very pure, high-resistivity silicon layer grown on a low resistance wafer.



EPITAXIAL CONSTRUCTION

A thin pure silicon epitaxial layer provides high breakdown voltage, low capacitance and fast reverse recovery. Added mechanical strength, low resistance path to the collector connection are made possible by thicker, low resistivity supporting wafer.

SILICON PLANAR RELIABILITY

An integral silicon oxide surface permanently protects the junction against contamination from the start of manufacture.

ADVANTAGES

Increases current handling capabilities of diode matrices without reducing speed. Decreases number of gate amplifiers between diode gates in series diode logic circuitry.

APPLICATIONS

High-speed, high conductance applications such as avalanche circuitry; core drivers; logarithmic amplifiers for pulse applications; critical circuitry requiring high conductance and low internal power dissipation, without sacrificing speed.

FD600 GUARANTEED CHARACTERISTICS

Forward Current	:	200 mA (min.) @ 1 Volt
Breakdown Voltage	:	75 Volts (min.) @ 5 μA
Capacitance	:	2 $\mu\mu$f (max.) @ 0 Volts
Reverse Current	:	50 mμA (max.) @ 50 Volts
Power Dissipation	:	500 mW @ 25°C

REVERSE RECOVERY TIME SPECIFIED FOR YOUR USE

- For magnetic memory applications

  Fast recovery with no turn-off current required

  t_{rr}=20 mμsec (I_F = 200 mA, I_R = 0 mA)

- For current mode switching in driver applications

  Fast recovery with high forward conductance

  t_{rr}=2 mμsec (I_F=I_R=10 to 400 mA)

- For diode logic applications

  Fast recovery with low reverse current

  t_{rr}=4 mμsec (I_F=10 mA, I_R=1 mA, recovery to 0.1 mA)

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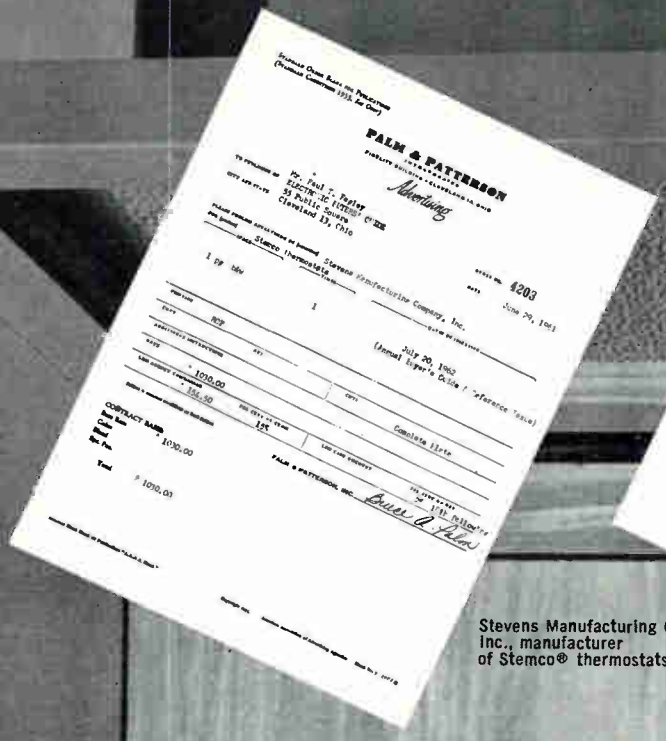
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION



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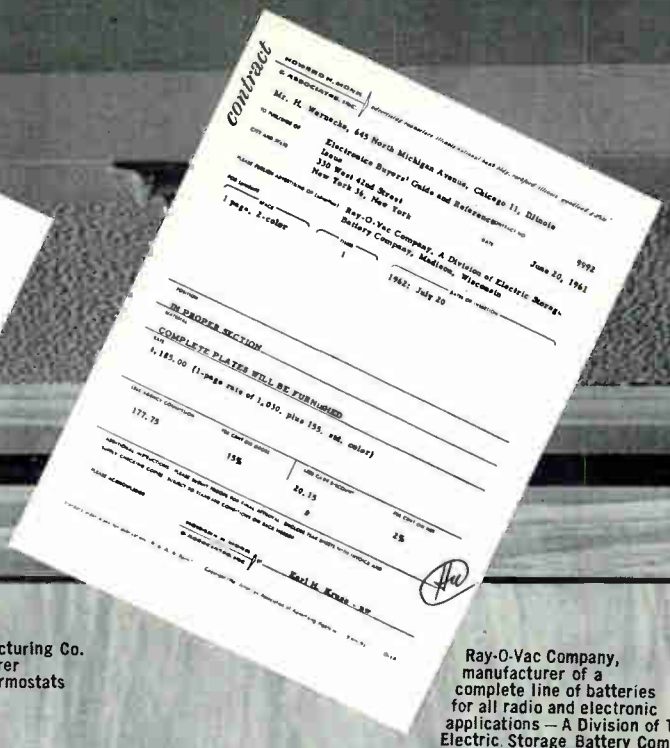

Ray-O-Vac Company, manufacturer of a complete line of batteries for all radio and electronic applications — A Division of The Electric Storage Battery Company

OVER THE TRANSOM — *More than a year prior to issue date*

One month before the 1961-62 **electronics** BUYERS' GUIDE and Reference Issue was off press, unsolicited, signed contracts for space in the 1962-63 EBG started coming in... an outstanding display of advertiser confidence!

This belief in EBG as the *basic buying book* in the field of electronics has been enjoyed by the BUYERS' GUIDE for more than twenty years. The accuracy of its Product Listings, its unique Reference Section (and new exclusive features in the current issue, including the annual Index of Articles that has appeared in **electronics,** plus Abstracts of engineering articles)... these and many other features inspire confidence so that EBG'S Advertiser Index reads like the "electronics social register." More advertisers (648) used the 1961 EBG than any other catalog-directory serving the electronics industry. Reserve *your* space in the 1962-63 EBG now!

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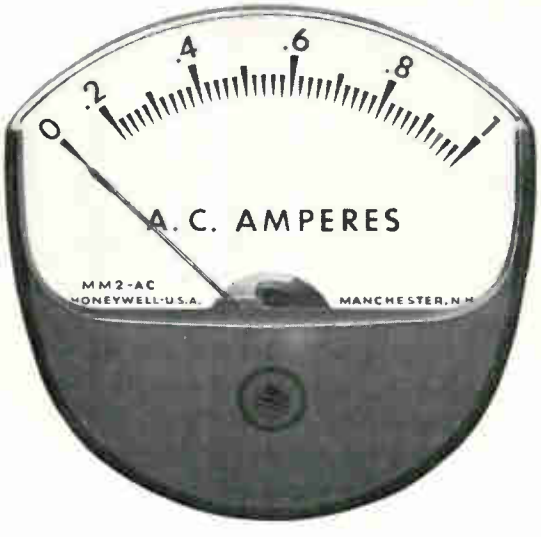

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Item: Homogeneous alloys of aluminum-3% boron, indium-3% aluminum, eutectic gold alloys and many others available.

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EIC

115/60-BER-12/600, in case

50 amp power supplies 0.1% regulation

Model	Output Voltage*	Ripple	Delivery	Price
115/60-BER-12/600	12	1 mv, rms	From stock	$ 945
230/60-BER-28/1400	28	2 mv, rms	Less than 30 days	$1750

*Output voltage adjustable over ±17% range.

These supplies have magnetic circuit breakers for overload protection, metered outputs, and remote sensing capability. Optional features include modifications for parallel operation and remote programming. Available for 19-inch racks or in case mountings.
Write for complete specifications on these and many other EIC power supplies.

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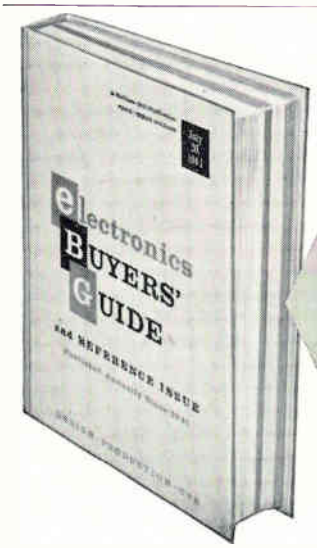

Seen the new IDEA INDEX IN EBG?

The INDEX to the editorial articles in **electronics** magazine, previously published annually in a December issue, now appears ONLY in the EBG. Another original EBG idea that saves time and trouble for users! Keep your EBG copy on your desk!

EXTRA!

Also in the EBG are condensed ABSTRACTS of *all* the editorial feature articles which have appeared to date in 1961. Another reason why EBG is used more by all four – men in research, design, production and management.

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to meet
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Conditions

New "Switching" Power Supply Gives More Current at Less Cost

Just out. Con Avionics announces a new line of transistorized "switching" power supplies that provide more current, more reliable current, at a lower cost to you.

The secret? This unit continuously turns itself on and off. The result is exceptionally high current for its size and price. High efficiency is built in through low pass dissipation, high reliability, minimum components and small size. Most of the semi-conductors operate in the switch mode, adding to the long life of the supply.

Priced to compete with magnetic amplifier and constant voltage power supplies, the performance characteristics are decidedly superior. Like all Avionics power supplies these new "switching" power supplies are designed and tested by "Worst Case Analysis" for virtually failure-proof performance.

Voltage Range	50 Amp	30 Amp	20 Amp	10 Amp
24 — 32 V DC	SP28-50 $820.00	SP28-30 $590.00	SP28-20 $525.00	SP28-10 $450.00
18 — 26 V DC	SP22-50 $820.00	SP22-30 $590.00	SP22-20 $525.00	SP22-10 $450.00
10 — 20 V DC	SP15-50 $820.00	SP15-30 $590.00	SP15-20 $525.00	SP15-10 $450.00

Prices subject to change without notice.

CONSOLIDATED AVIONICS CORPORATION
800 Shames Drive, Westbury, New York

☐ Send literature on new "switching" power supplies
☐ Have representative call with demonstrator

Name.....

Company.....

Street.....

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Other Transistorized Power Supplies

GUARANTEED

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Conditions

AC-DC "MODULAR" POWER SUPPLIES
2 to 305 VDC; 100 ma — 1 amp

Unique heat sink construction of these supplies permits operation in ambient temperatures up to 65°C, when mounted on a typical rack chassis. Power to 30 watts. Adjustable output. 0.1% regulation. Reliable short circuit protection. Small size makes it ideal for electronic assemblies or systems. Guaranteed for two years to meet all specifications.

Input.....105 to 125V AC
Line Regulation.....0.1% or 10mv
Load Regulation.....0.1% or 20mv
Stability.....±0.25% for 8 hours
Ripple.....0.02% or 5 mv rms
Response time.....less than 100 microseconds
Operating Temperature . . . 0C to 65C on a typical rack chassis
Temp. Coeff.....0.01% per C.

WIDE RANGE POWER SUPPLIES
0-50 VDC/2, 5, 10 and 15 Amp.

For unusually wide voltage range and high current capacity. Three rack-mounted series available with 0.5%, 0.10% and 0.01% regulation. Completely transistorized. Regulated without "gimmick" pre-regulators. Positive short circuit protection. Guaranteed for two years to meet all specifications. Includes remote sensing and programming, fan cooling with thermostat protection. Over-voltage, current-limiting option.

LOW COST GENERAL PURPOSE POWER SUPPLIES
0-60VDC/0-1.5 Amp.

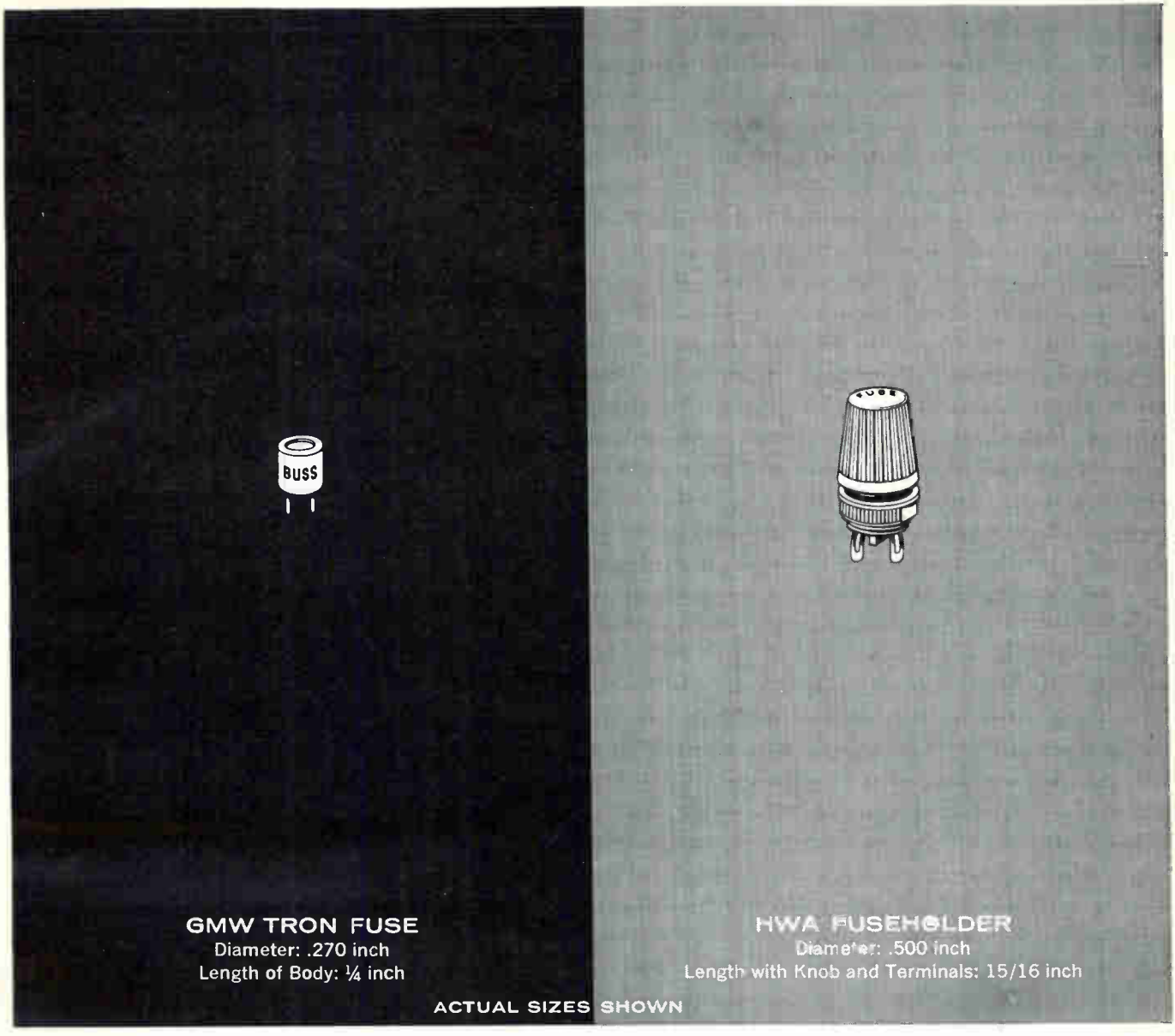
A durable, general purpose power supply available with regulated and unregulated outputs. Simple and straightforward circuitry with components used conservatively for long trouble-free life and high reliability. Designed for ease of operation and convenience in bench-mounting. Cases heavily dimpled so two or more units may be stacked on top of each other.

CON AVIONICS

Consolidated Avionics Corporation, 800 Shames Drive, Westbury, L.I., N.Y.

WARRANTY

Con Avionics guarantees that its power supplies will meet their published specifications for two years after date of shipment. Guarantee does not cover transistors, diodes, fuses.



Another BUSS sub-miniature fuse and holder combination

EXTREME RELIABILITY UNDER HIGH SHOCK AND SEVERE ENVIRONMENTAL CONDITIONS.

Rigid construction of fuse and holder assures extraordinary reliability under high shock and vibration conditions. Fully insulated ceramic body isolates fusible element from effect of dust, corrosion, moisture and vapors.

DESIGNED FOR SPACE-TIGHT APPLICATIONS

Panel Mounted. Holder can be mounted on panel by hand. No special tool required to run down holding nut.

Prong type contacts on fuse make it easy to install or replace.

A knob for the holder may be used to make holder water proof from front of panel.

HOLDER CAN BE MOUNTED IN PRINTED CIRCUITS

Terminals of holder can be inserted into holes and soldered on printed circuit board without additional forming.

If desired, GMW fuse may be used without holder and mounted directly into printed circuit boards.

AVAILABLE RATINGS FOR GMW FUSES.

Fuses are made in sizes from 1/10 to 5 amperes for use on circuits of 125 volts or less where fault current does not exceed 50 amperes.

Transparent window in end of fuse body permits visual inspection of fusible element.

Before crystallizing your design using subminiature fuses be sure to get full data on the Buss GMW fuse and HWA holder combination.

Exploded view of GMW-HWA fuse & holder combination.

IN THE BUSS LINE, you'll find the type and size fuse to fit your every need . . . plus a companion line of clips, blocks and holders.

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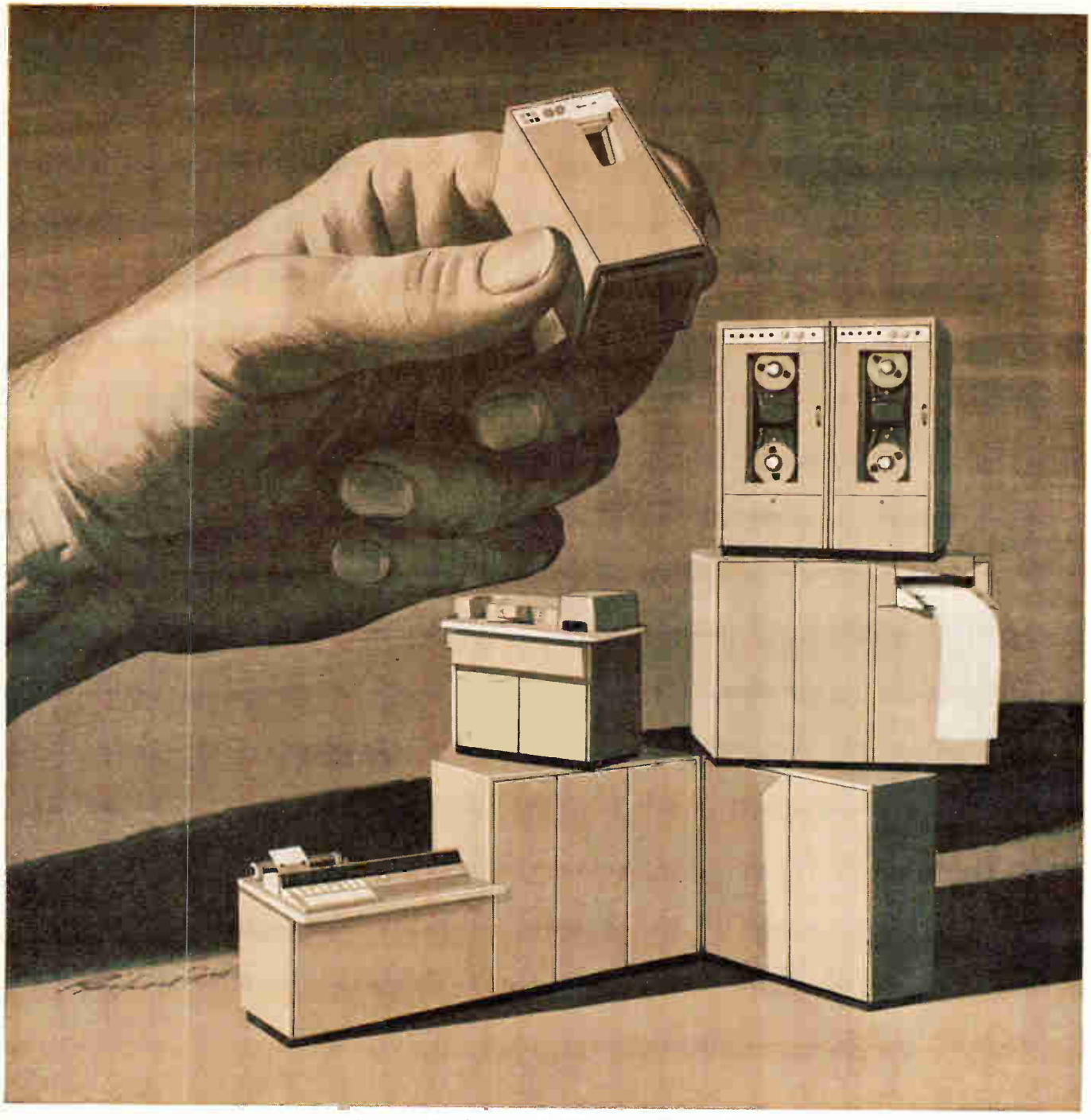
CIRCLE 59 ON READER SERVICE CARD



BUILD A BETTER FUTURE AT NATIONAL'S ELECTRONICS DIVISION IN LOS ANGELES

Demand for the National 315 Electronic Data Processing System has brought about rapid expansion at National's Electronics Division. In less than two years the Division's facilities in Southern California have tripled in size.

Because its major activity is development of systems for established commercial markets in 120 countries, the Electronics Division is advancing on exceptionally solid ground. These vast markets, served by National's Marketing Division, point to excellent career stability for the men who create the systems.

If you qualify for one of the new openings, you will experience constant technological challenge and continuous opportunity for personal growth. You will also enjoy discovering that Southern California provides year-round opportunities for recreational and cultural activities.

CAREERS NOW OPEN IN THESE COMPUTER AREAS

TRANSISTOR CIRCUITRY □ SYSTEMS ENGINEERING □ SYSTEMS TEST ENGINEERING □ SCIENTIFIC, DIAGNOSTIC AND ACCEPTANCE PROGRAMMING □ PRODUCT ENGINEERING □ PRODUCT DESIGN ENGINEERING □ RESEARCH ENGINEERING □ MILITARY SYSTEMS DESIGN

PLEASE SUBMIT RESUME IMMEDIATELY TO ARRANGE FOR INTERVIEW DURING EASTERN JOINT COMPUTER CONFERENCE IN WASHINGTON. Write to Norval E. Powell, Personnel Manager, at the address below.

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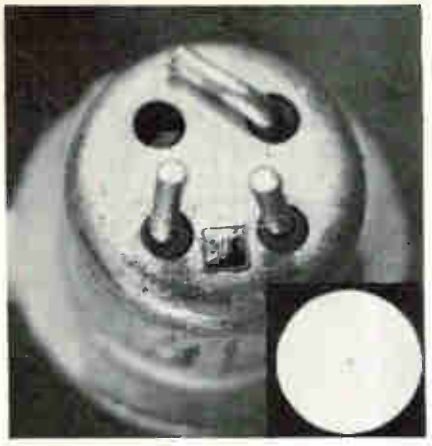
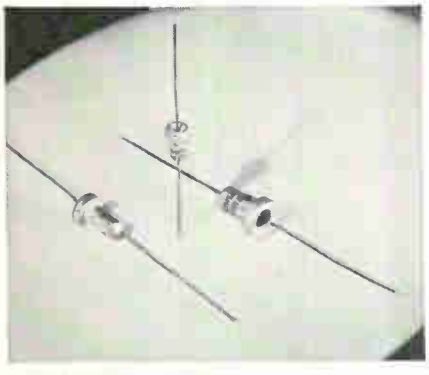
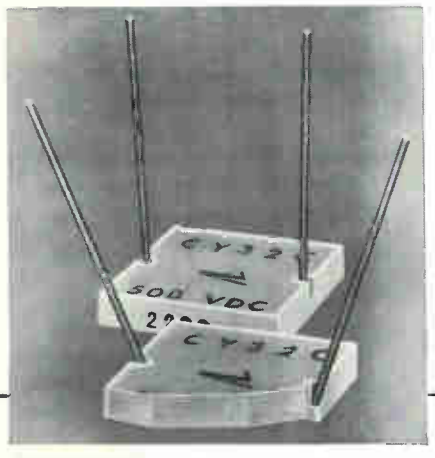


TRANSISTORS—Shown here in magnification is a Mesa transistor with fine gold wire. Handy & Harman manufactures this whisker wire to exact tolerances and highest purity standards. The cap is gold plated from Handy & Harman fine gold anodes. Photo courtesy of Western Electric.



CAPACITOR CANS—These tantalum electrolytic capacitors are completely leaktight and highly resistant to corrosion. The containers that are also used to seal the liquid and internals are drawn from Handy & Harman fine silver sheet. Photo courtesy of Fansteel Metallurgical Corporation, North Chicago, Ill.



CAPACITORS—Electrodes in these solid-state porcelain capacitors are formed from silver paste derived from Handy & Harman silver flake. Other types of capacitors for high-temperature applications have lead wires of Handy & Harman Consil 998, a nickel-bearing alloy. Photo courtesy of Vitramon, Incorporated, Bridgeport, Conn.

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. . . just a few of the jobs involving HANDY & HARMAN precious metals

Handy & Harman's effectiveness in supplying the semiconductor and related fields is based on long experience with precious metals, coupled with our interest and ability in working closely with designers, engineers and manufacturers in the electrical and electronics industries.

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Overnight delivery on many items at factory prices

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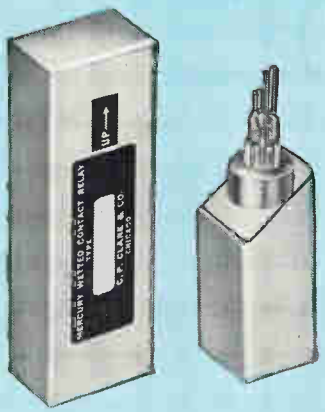


NOW AVAILABLE
...mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

Your nearby CLARE distributor can now supply you with the new CLARE mercury-wetted relays, steel enclosed and ready for mounting. They combine the famous CLARE billion-operation reliability with unusual ease of handling and application. You can choose either the standard CLARE HG relay module or the HGS, super-fast and super-sensitive. Each module contains the CLARE mercury-wetted contact switch capsule with contacts continually wetted by capillary action. They never bounce, never get dirty, never weld and never wear out.

A compact telephone type relay of unequaled long life and superior performance.

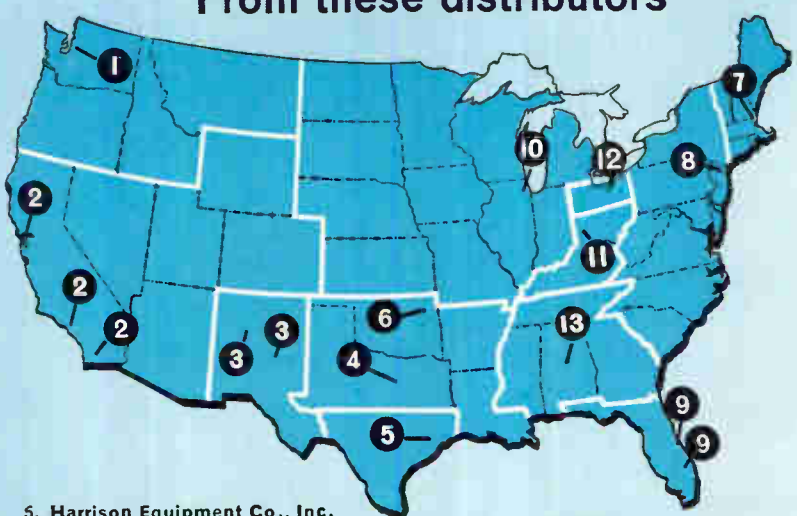
A highly reliable switching device for single or multiple circuit control... wide mounting versatility.

Single or multiple switch capsules potted in steel container. Gives billions of operations with no maintenance.

A crystal can relay with unusual flexibility and a variety of mounting styles.

# of top-quality Clare relays

From these distributors



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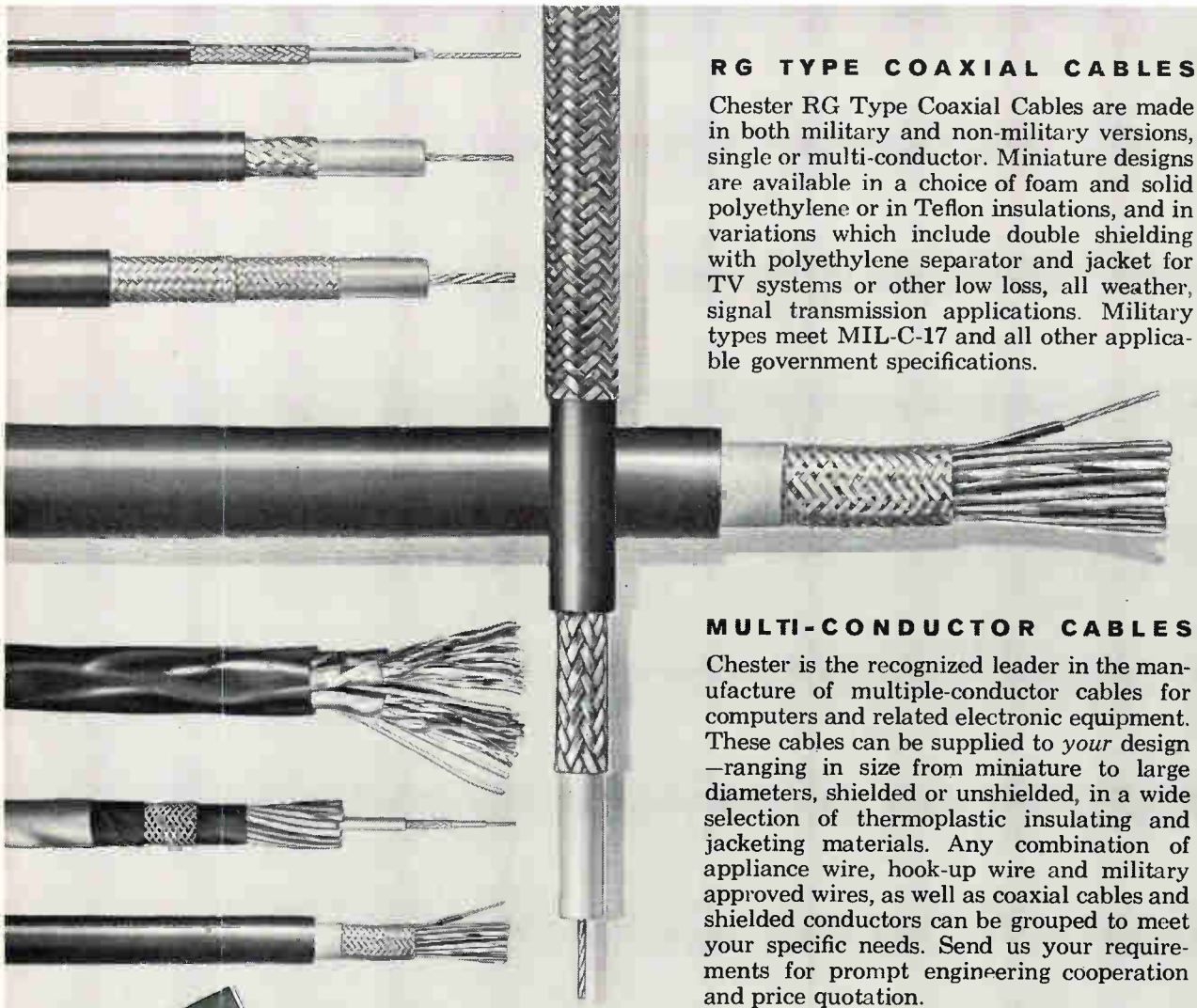

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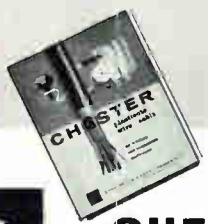

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genus: homo • species: sapiens discipline: factors engineering

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VIBRATION-PROOF CARD PACKAGING

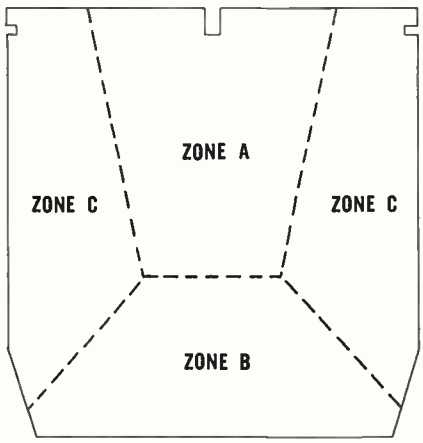
Pre-test data used to prevent vibration-induced failure of parts leads on printed circuit cards

Probably the most unrelenting adversary of packaging engineers is vibration, the all too persistent specter that hovers malevolently over complex electronic systems. Hours, days, weeks, and even longer, especially during pre-delivery system tests, are repeatedly lost as technicians and engineers patiently stalk malfunctions arising from parts rendered ineffectual by vibration.

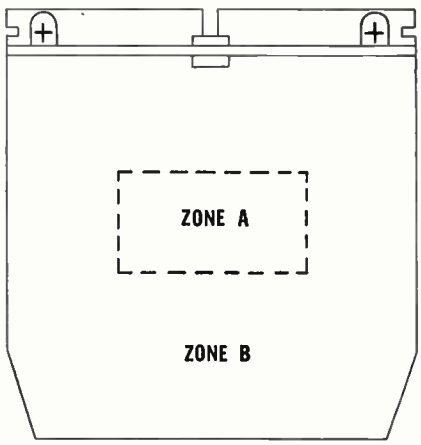
Packaging engineers at Litton Systems have devised still another technique of combatting this eternal bugaboo. They have developed a relatively simple pre-test means whereby each of the innumerable parts attached to printed circuit cards in a digital system can be so located and positioned on a card that the probability of its resistance to "the shakes" is virtually 100 percent assured.

The essence of the method, which was perfected for application on an advanced digital tactical data system intended for installation in a carrier-based airborne early-warning and control aircraft, is exemplified in the accompanying diagram. The over 2,000 printed circuit cards in the system were classified into two basic types, the only difference between the two being that type II is equipped along the forward edge with a transistor holder bracket.

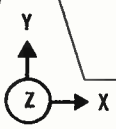
Notwithstanding the small size (3″ x 3″) of the card, vibration characteristics were compiled for several zones of each card type. On the basis of this data, zones of permissibility and non-permissibility were established for each part to be attached to the card according to the size, weight, and shape of the part.

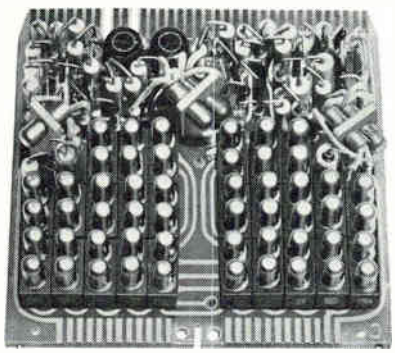


TYPE I



TYPE II





shift-register assembly circuit card with components arranged according to zoning methods.

An A-size capacitor, or equivalent part, for example, could be placed in any zone of either card type with the part axis oriented in any direction. An R-size capacitor or its equivalent, however, could not be placed in zone A of either card type, but could be placed in zone B and oriented along the X-axis on type I, in zone C along the Y-axis of type I, and in zone B along either the X or Y-axis of type II. For another, a .50-inch square by .47-inch high coil could be oriented along the Z-axis in all zones of both card types with the exception of zone A of type I.

The parts placement and orientation data for capacitors, resistors, transistors, diodes, coils, and equivalent parts fit readily on a single oversized sheet. The proof of the technique is in thousands of printed circuit card modules that have consistently met not only the requisite airborne electronic equipment specifications for vibration, but the even more stringent specifications for missile-borne equipment.

Ingenuity of this kind is characteristic of engineering performed at Litton Systems. Those who feel inclined to work in an environment that encourages and inspires thoughtful and fruitful engineering will find satisfaction at Litton Systems. Write to: S. L. Hirsch, Litton Systems, Inc., Data Systems Division, 6700 Eton Avenue, Canoga Park, California; or telephone DIamond 6-4040.

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Power Drain	2-4 mw @ 3 volts
Fan-Out (TI SN 510, 512, 514, 515)	4
Fan-Out (TI SN 511, 513)	20
Propagation Delay	75 to 450 nsec
Power Supply	3 to 6 volts
Temperature Range	−55° to +125°C

UNIT	TI SN 510	TI SN 511	TI SN 512	TI SN 513	TI SN 514	TI SN 515
FUNCTION	Flip Flop, Counter	Flip Flop with emitter follower output	NOR/NAND Gate (6 input)	NOR/NAND Gate (6 input) with emitter follower output	Two NOR/NAND Gates (3 inputs each)	Exclusive OR
	Clock pulse is internally capacitive-coupled					

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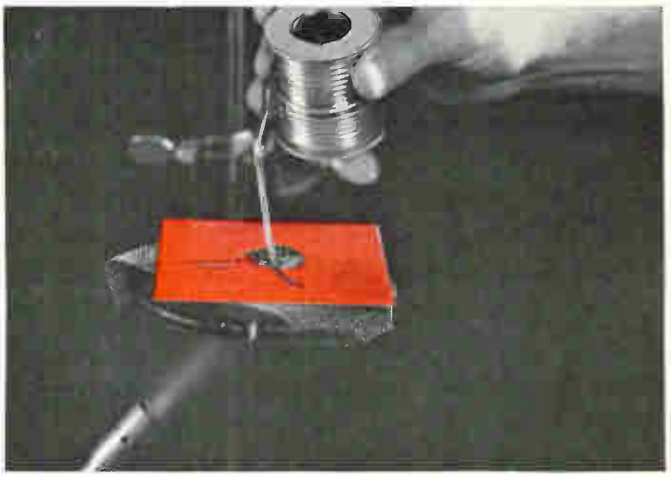
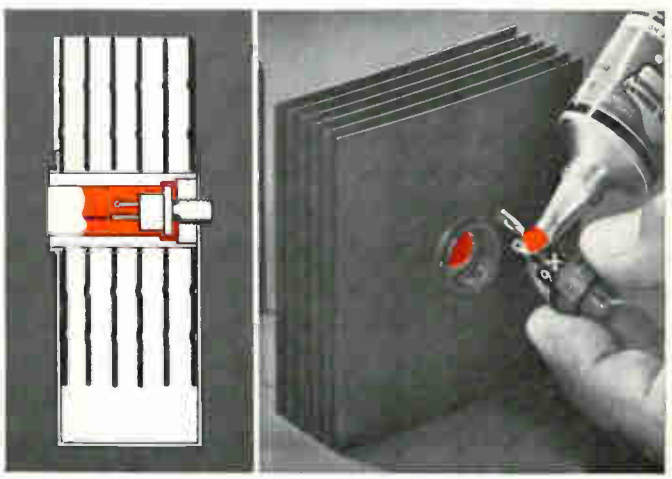


Silicone compound for heat sink seal

Heat sinks built by Fairfield Controls, Inc., Stamford, Conn., combine pure copper fins with Dow Corning 3 Compound to assure full load operation of silicon control rectifiers within the maximum allowable junction temperature of 125 C. Dow Corning compound with its petroleum jelly-like consistency, provides excellent heat transfer between the 25.5 amps diode shown here and the metallic parts of the heat sink assembly. The operating portion of the rectifier is inside the heat sink, with silicone compound to facilitate heat transfer from the entire diode body to the heat sink proper. At the same time, moisture and contaminates are sealed from the diode lead connections.

CIRCLE 291 ON READER SERVICE CARD



Key to stability — silicone fluid

Dow Corning silicone fluid is used in a new line of hermetically sealed precision film resistors developed by Key Resistor Corporation of Gardena, California, to "provide the ultimate in long term life and stability." According to Key engineers, "the unique silicone fluid filled construction results in excellent heat dissipation characteristics — minimizes effects of severe overloads." Dow Corning silicone fluids are used as filling and cooling media in numerous electronic and electro-mechanical applications because they maintain initial viscosity over a wide temperature range, are stable at high temperature, are excellent dielectrics . . . offer numerous other advantages.

CIRCLE 292 ON READER SERVICE CARD

Free 12-page manual, "Silicones for the Electronic Engineer".
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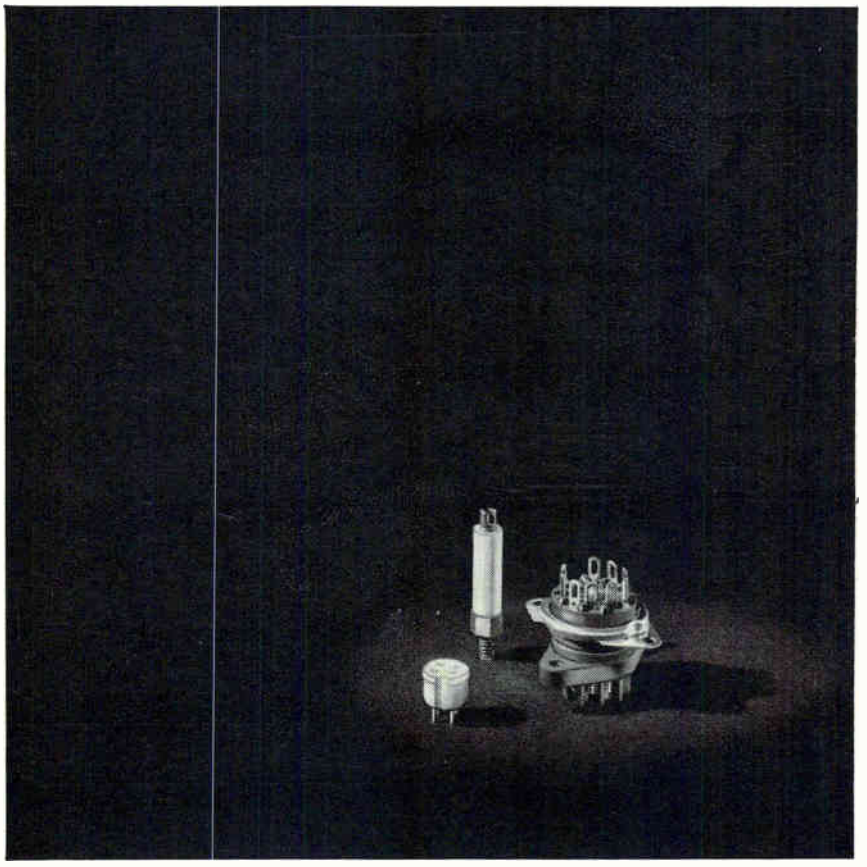

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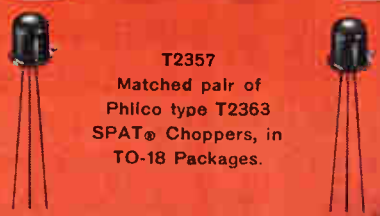

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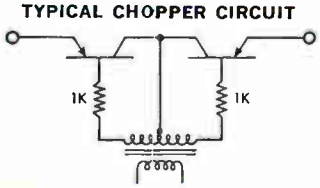
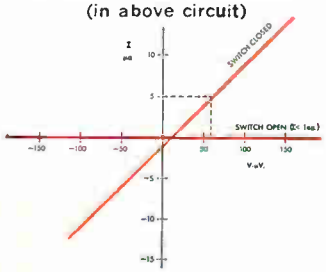
Emitter Collector Current $I_{EBO}(V_{EB} = -10V)$	0.001 μa max.
Offset Voltage $V_{EC}(I_B = -200\ \mu a, I_E = 0)$	1.5 mv max.
Offset Voltage V_{EC}(T2357 Matched Pair, $I_B = -1ma$ at all temperatures from 25° to 85° C)	50 μv max.

TYPICAL CHOPPER CIRCUIT



T2363: I-V CHARACTERISTIC
(in above circuit)



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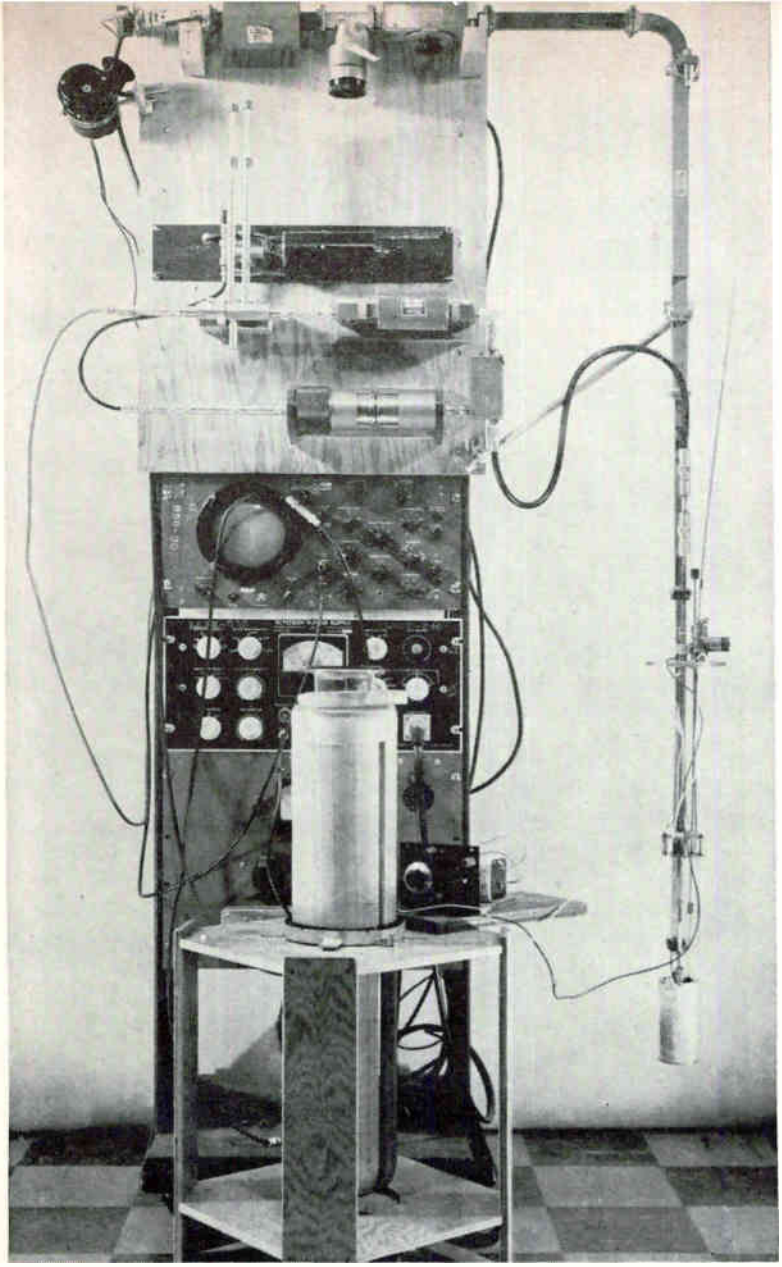
By THOMAS MAGUIRE
New England Editor



Tunable solid-state ruby maser amplifies 1,350-1,450 Mc. Variable magnetic fields up to 7 Kgauss are provided by niobium solenoid at lower right

Electro-Optical Developments Highlight NEREM

ENGINEERING ADVANCES will be mirrored in depth next week in Boston during the 15th Northeast Electronics Research and Engineering Meeting. With a heavy R&D flavor characteristic of the industry in New England, more than 90 papers at 22 sessions will detail recent advances.

In addition to descriptions of current work on optical masers, both gaseous and solid-state, modulation concepts will be explored.

An experimental device for modulation of optical maser output has been operated on a pulsed basis at 9,250 Mc.[1] The modulator uses electro-optical effects in crystals of the dihydrogen phosphate type, in this case KDP. About 2 Kw is required to produce a peak phase retardation of about 1.9 radians. A traveling microwave modulating field in synchronism with the optical wave permits use of a long sample with reduced power. Forward wave component of a TM_{01s}

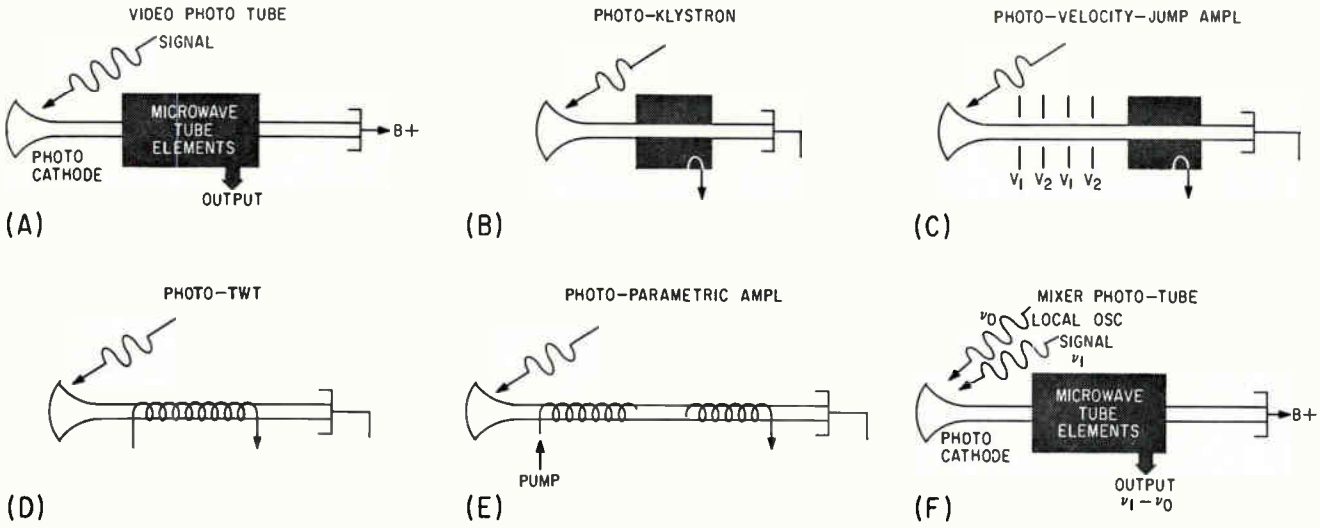


FIG. 1—Prebunched beam from photocathode carries video modulation in simplest phototube for detecting amplitude-modulated light (A). Some phototube types for demodulation of light (B to E). Optical superheterodyne (F) responds only to optical frequencies within band corresponding to i-f bandwidth away from the local oscillator

cavity standing wave is used. The backward wave has no net effect on the light when the microwave velocity equals the optical velocity.

Ideal material for microwave electro-optic modulators would exhibit a large electro-optic effect, have optical phase velocity close to microwave phase velocity, possess isotropic optical symmetry, and belong to a crystal class which permits the modulating field to be applied normal to direction of light propagation. Many of the requirements are contradictory from a physical viewpoint.

Ability to confine the maser beam to a small cross-section with small divergence makes low-power modulation with KDP feasible. It is quite lossy at X-band, so most of the power in the cavity is dissipated in the crystal volume. By confining the beam to a small cross-section and reducing cross-section of the KDP rod, power dissipated may be reduced.

Experiments at Stanford University have produced what is believed to be the broadest-band phototube yet built, and the first mixing of two coherent light signals to yield a coherent microwave output.[2]

Figure 1A shows the simplest form of microwave phototube for detecting amplitude-modulated light. The photocathode serves the same purpose as the video crystal detector at radio frequencies.

Figures 1B to E show some of the forms such tubes might take. The photo-klystron will serve for narrowband microwave signals. Modulation on the beam can be preamplified by velocity-jump methods. The device would be like a low-noise microwave tube gun operated so as to amplify rather than de-amplify the initial cathode current modulation on the beam. The twt type will yield greater bandwidth; and the parametric pumping principle can be used also to preamplify beam modulation.

These same microwave phototubes can be employed as optical superheterodynes (Fig. 1F). An optical local oscillator at frequency f_o and an optical signal at f_1 will produce a photo current at the difference frequency $f=(f_1-f_o)$, which can be amplified and detected by the microwave-tube elements. The photocathode is the mixer, and the electron beam and microwave-tube elements are the i-f amplifier. Such an optical superheterodyne offers unprecedented selectivity: it responds only to optical frequencies within a band corresponding to the i-f bandwidth away from the local oscillator. The two light beams must be in phase everywhere on the cathode or cancellation effects occur.

In the Stanford experiments, a ruby laser's output consisting of a large number of discrete spectral components spaced by 600 Mc was fired at an improvised phototube. These outputs beat or mix in the cathode. Strong outputs are obtained at 1,800, 2,400, 3,000, 3,600 and 4,200 Mc. The microwave signals are coherent and nearly monochromatic; zero-beat patterns can

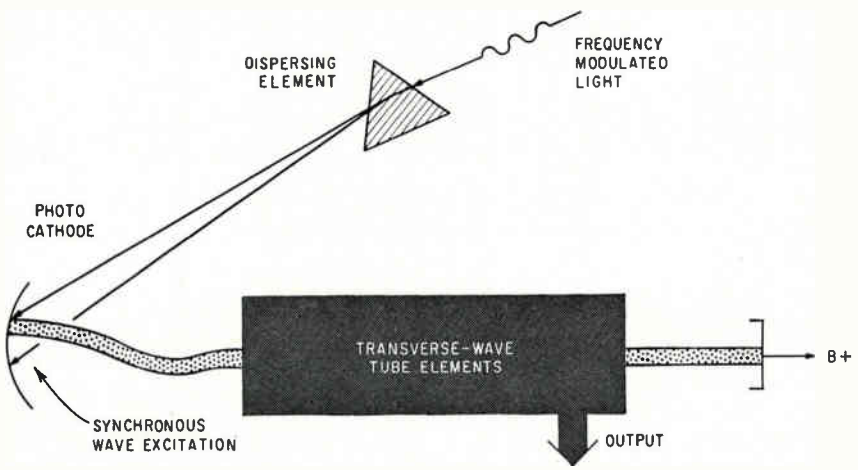


FIG. 2—Prism of novel microwave discriminator phototube converts f-m to ray-angle modulation

be obtained by mixing them with a microwave signal generator tuned to the same frequency.

Figure 2 shows a microwave discriminator phototube for demodulating frequency-modulated coherent light. The prism or other dispersing element converts the f-m to ray-angle modulation and hence position modulation on the photocathode. The resulting sideways modulation of the electron beam is, in microwave-tube terms, initial excitation of the synchronous cyclotron transverse waves, which can be amplified and detected by appropriate transverse-wave-tube elements.

The extraordinary intensity of light beams from pulsed optical masers can be exploited for the production of optical harmonics.[3] These monochromatic beams, when focused, exhibit electric fields of the order of 10^5 volts per cm.

A commercially available ruby optical maser which produces approximately 3 joules of 6943-A light in a one-millisecond pulse is utilized. The light is passed through a red filter to eliminate the xenon flash background and is then brought to a focus inside a crystalline quartz sample. The emergent beam is sampled by a quartz prism spectrometer equipped with red insensitive spectrographic plates. Dense images were obtained at the second harmonic ($\sim$ 3472 A).

The hydrogen maser promises to serve as a source of radiation of unprecedented spectral purity and frequency stability.[4] It uses a hyperfine transition in the ground state of atomic hydrogen and in its present form obtains the required non-equilibrium distribution of atoms in the resonance states by an atomic beam.

The hydrogen maser, unlike previous devices, uses the storage box technique. The atoms are stored in a container which has non-interacting walls—the hyperfine state of the atom is not perturbed by wall collisions. The atoms can interact with the radiation field for times vastly longer than that necessary for a single traversal across the storage box, and the resonance width of the device is consequently extremely narrow. Calculations indicate that with an observation time of 1 sec the fractional width of the radiation spectrum is 10^{-15}.

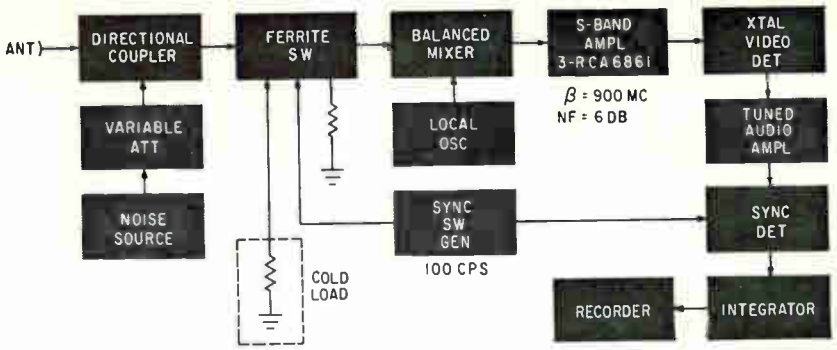


FIG. 3—Hybrid receiver using traveling wave tube intermediate-frequency amplifier

In the maser, hydrogen molecules are dissociated in a d-c or r-f discharge and effuse into a vacuum. A beam of the atoms passes through a state selector, a small hexapolar magnet, which deflects them toward the axis atoms in the upper hyperfine state, and these atoms are focused on the aperture of a quartz bulb. The bulb is lined with a non-interacting wall coating and is surrounded by a resonant cavity tuned to the hyperfine transition frequency. If the lifetime of the atoms is sufficiently long, and the beam flux great enough, the atoms radiate by self-induced stimulated emission and a signal at the resonance frequency is detected by means of a coupling loop.

It is anticipated that factors on which frequency stability depend can be controlled to allow operation to a stability of one part in 10^{13} for long periods.

Availability in the near future of intense fields produced at a reasonable price and in a compact package by superconducting magnets will have a significant impact on electronics and other fields.[5]

New alloys and compounds have given rise to small magnets which generate fields in the 30- to 40-kilogauss range. Of the common elements, niobium has the highest transition temperature, T_c (about 9 K). It also has the highest critical field strength, and solenoids of up to 10 kilogauss have been made with niobium wire.

For generation of intense and large-volume fields, most promising among the new materials are Nb_3Sn (T_c = 18 K) and Nb Zr (T_c = 11 K −12 K).

Small magnets using these materials have been built. One solenoid uses 2,800 ft. of wire with a core of niobium and tin, and produces 28.5 kilogauss at 4.2 K. Another solenoid, slightly smaller, contains 4,000 ft. of .010″ diameter niobium-zirconium alloy wire insulated with nylon and generates 33 kilogauss at 4.2 K. The same techniques and more wire should result in small 50-100 kilogauss solenoids.

An 8.6 mm radiometer designed to capitalize on the wide bandwidth capabilities of presently available twt's has been developed at MIT Lincoln Laboratory and used in lunar measurements.[6] Under development is an 8.7-mm system using a maser, the alternate approach in radiometer instrumentation.

Under construction is a 28-foot spuncast parabolic antenna which hopefully will give the required precision for 8-mm operation. With the 28-foot paraboloid and a traveling-wave maser, sensitivity to radiation from Venus will be increased by two orders of magnitude.

Lincoln Laboratory also plans to use the 28-foot dish, a maser preamplifier and tens of watts of cw power for an 8.6 mm radar bounce off the moon. Angular resolution provided by this system would be smaller than the moon's subtended angle. In the two approaches to radiometry twt's have the advantage in bandwidth and masers in noise temperature.

Lincoln Lab's system using twt's is shown in Fig. 3. Three twt's are operated in series as an i-f amplifier at S-band with a gain of 75 db. The signals are converted from Ka band to S-band by a special wide band, balanced mixer. This radiometer shows good capability for measurement of weak thermal signals such as in temperature measurement of planets.

Most sensitive parameter affecting ultimate sensitivity of a radiometer is the internal noise of

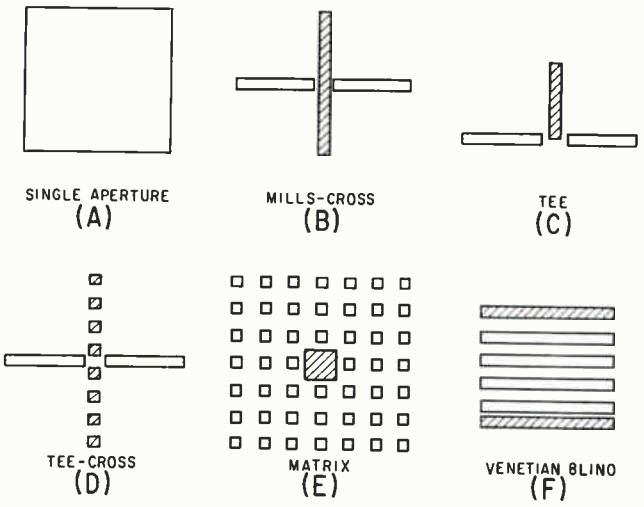


FIG. 4—Equivalent pencil-beam antennas. Shaded part is phase-switched with nonshaded part in (D)-(F).

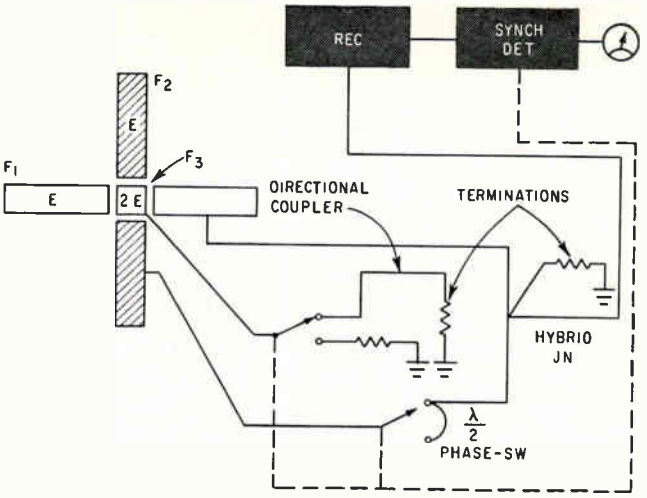


FIG. 5—Modification to make Mills cross sensitive to extended sources

the preamplifier. Masers, especially traveling wave types, appear attractive here. Noise contributed by other components far outweighs maser noise.

In superpower microwave tubes, the debate is intensifying over the crossed-field approach vs. linear beam tubes.[7, 8]

Merit of linear beam tubes is seen as inherent in the physical separation of the three basic functional regions of such devices: electron beam generation; r-f interaction; and collection of spent beam.[7]

Linear beam tubes now in development feature large cathode area protected from back bombardment and resultant deleterious effect on life, low dissipation density circuit, whose only function is r-f interaction and arbitrarily low collector power density.

Operational and constructional advantages are seen resulting from the simplified energy conversion system of a crossed-field device.[8] It converts the potential energy of the power supply directly into r-f energy, while other classes of microwave tubes first convert to kinetic energy of electron motion, from which r-f energy is extracted.

Progress in crossed-field devices has been principally through the continuous-cathode class. High average power ratings can be attained in these compact devices only if suitable means can be found to handle the inherent power losses. These power losses appear as heat which must be carried away.

The main power loss consists of heat generated by the relatively low kinetic energy of spent electrons as they strike the combined anode and r-f network of the tube.

Present progress results from the need for handling the greatly increased power levels at both the input and output of super power devices, by quasi-optical means; and also from the development of the concept of axial gain in a crossed-field device which permits an increase of anode area by several orders of magnitude. Close analogy of the latest device in appearance and function to a microwave lens—but with integral gain—has led to the name Electromagnetic Amplifying lens (EAL). Theory indicates capability of average power in the megawatt range.

As an alternative to larger paraboloidal or spherical reflectors, many ingenious phase-switched antennas such as the Mills cross have been developed in recent years. They offer very high resolution and sensitivity at a relatively low cost, but with some limitations.[9]

In a Mills cross antenna two long broadside arrays are placed in the form of a cross. The pencil beam is formed by multiplying the fan-beam voltage responses of the two linear arrays. Multiplication is usually done by connecting the two arrays of the cross alternately in phase and out of phase to a receiver, and by recording the modulated component of the receiver output.

Some arrangements of phase-switched antennas are shown in Fig. 4. The resolution of a tee-

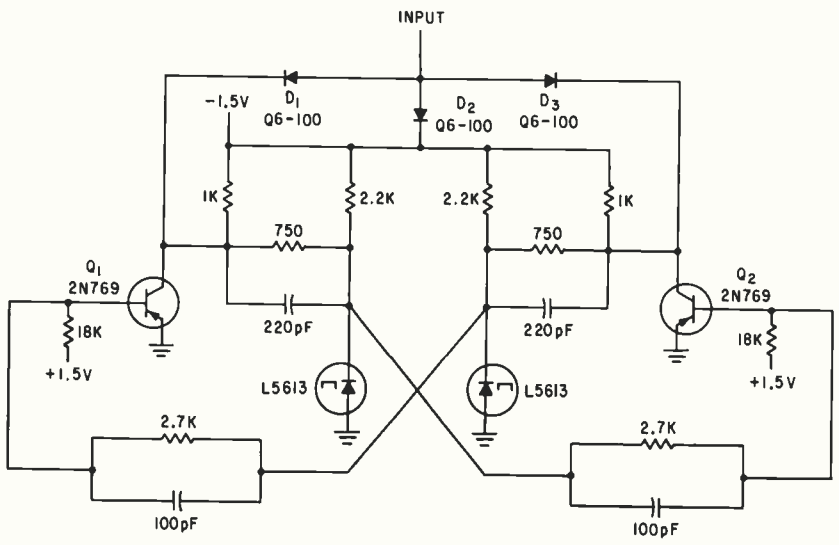


Fig. 6—Micro-energy flip flop

antenna (Fig. 4C) is the same as of the original cross (Fig. 4B). The tee-cross has been evolved for design of the large Benelux cross antenna, 3-5 Km long, to achieve a 1 minute of arc pencil beam width at 400 Mc.

The phase-switched matrix array of Fig. 4E makes it possible to increase the resolution of a single aperture of modest size. Any spurious lobes arising because of antenna adjustment errors are distributed in all directions.

For high resolution along with high sensitivity, R. N. Bracewell has suggested the arrangement in 4F. The antenna consists of a row of cylindrical parabolic reflectors. Grating responses caused by periodicity in the aperture illumination are suppressed by phase-switching the central part with the outer two elements.

The scheme outlined in Fig. 5 makes the Mills cross sensitive to extended sources. Field distribution impressed over the central portion of the cross is made twice in amplitude to that elsewhere. The central portion is periodically chopped in synchronism with the phase-switch. This makes the Mills cross uniformly sensitive to all spatial frequencies from zero to a certain cut-off, the latter dependent on the over-all length of each arm.

A logic circuit, termed "tunnel diode-coupled micro-energy transistor logic", combines the desirable operating characteristics of the tunnel diode and the transistor.[10]

In the circuit, fan-in and fan-out capabilities per unit dissipation are improved by five to 10 times over existing types of logic schemes. Switching speed of this tunnel diode-transistor hybrid circuit depends primarily upon the transient response characteristics of the transistor. The flip flop in Fig. 6 may be triggered by conventional techniques. Use of tunnel diodes allows low supply voltages resulting in low circuit dissipation, with a minimization of the collector circuit RC time constant; and provides voltage drive which results in fast switching speeds.

Metal deposition techniques called scribe-plating and trace-plating are suitable for a wide range of sizes of semi-conductor devices and, in particular, for microminiature devices.[11]

Minute nucleation centers for chemical or electrolytical plating of the semiconductor are created by suitable preparation of the surface, either by removal of semiconductor material along microscopically fine lines scribed with a hard stylus, or by deposition of a microscopically fine trace along the surface by abrasion from a soft metallic stylus.

Scribing is performed with a pointed stylus made of a hard material such as diamond or steel, using radius and applied pressure as parameters to control the width and depth of the scribed line. Subsequent plating, usually electrolytic, nucleates preferentially along the scribed regions.

In trace-plating the stylus is made of a soft and suitably pointed metal. Moving the stylus along the semiconductor surface causes a very small amount of the stylus metal to be deposited by abrasion. Though usually very thin, this deposit provides a nucleation center for subsequent plating.

All-chemical technique has been developed for fabrication of thin film circuits from titanium and its compounds.[12] Electronic characteristics of the oxides of titanium are shown in Fig. 7.

Fabrication with a molten salt process gives a complete coating of an inorganic substrate with a thick film of very pure titanium metal. After cleaning, a pattern of copper or other conductive material is electroplated onto the metallized substrate to produce termination areas or interconnection tabs. The circuit pattern is then fabricated from the metallized substrate by photoetching. External ribbon leads are fastened to the metallized pads by furnace brazing.

Conversion of selected areas of the continuous circuit pattern into a resistive or dielectric material is by an anodic process. Resistances are individually trimmed to precise values by further anodizing or mechanical operations. Capacitors are formed by the addition of a counterelectrode to the dielectric pattern and mechanically adjusted. Active devices are assembled to the circuit by spot welding, thermal compression bonding or soldering.

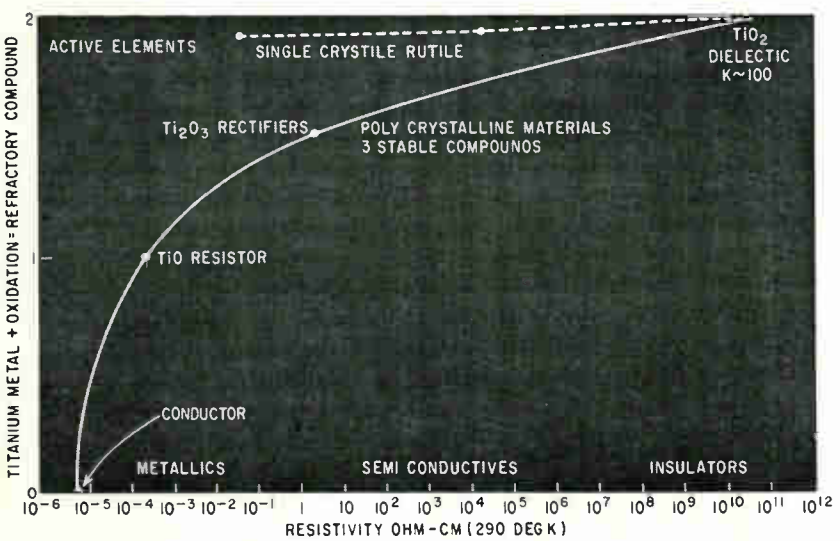


FIG. 7—Resistivity of the oxides of titanium covers 16 orders of magnitude

REFERENCES

(All papers prepared for the 1961 Northeast Electronics Research and Engineering Meeting, Boston.)

(1) I. P. Kaminow, Bell Telephone Laboratories, Microwave Modulation of Light By The Electro-optic Effect.

(2) A. E. Siegman, Stanford University, Microwave Phototubes and Light Demodulators.

(3) P. A. Franken, A. E. Hill, C. W. Peters, G. Weinreich, University of Michigan, The Generation of Optical Harmonics.

(4) D. Kleppner, Harvard University, The Hydrogen Maser.

(5) S. H. Autler, M.I.T. Lincoln Laboratory, Superconducting Magnets.

(6) J. W. Meyer, James J. Kirwan, David M. Towle, M.I.T. Lincoln Laboratory, Radiometric Instrumentation at Eight Millimeters.

(7) T. D. Sege, Sperry Gyroscope Co., Superpower Microwave Tubes—The Case for Linear Beam Tubes.

(8) W. C. Brown, Raytheon Co., The Cross-Field Approach to Microwave Super Power.

(9) G. Swarup, Stanford University, Mills Cross and Related Pencil-Beam Antennas.

(10) J. A. Ekiss and P. Spiegel, Philco Corp., A Low-Power, High-Speed Transistor, Tunnel Diode Hybrid Logic Circuit.

(11) W. Rindner and J. M. Lavine, Raytheon Co., Scribe- and Trace-Plating: New Techniques for Microelectric Semiconductor Devices.

(12) W. D. Fuller, Lockheed Missiles and Space Co., Titanium Thin Film Circuits.

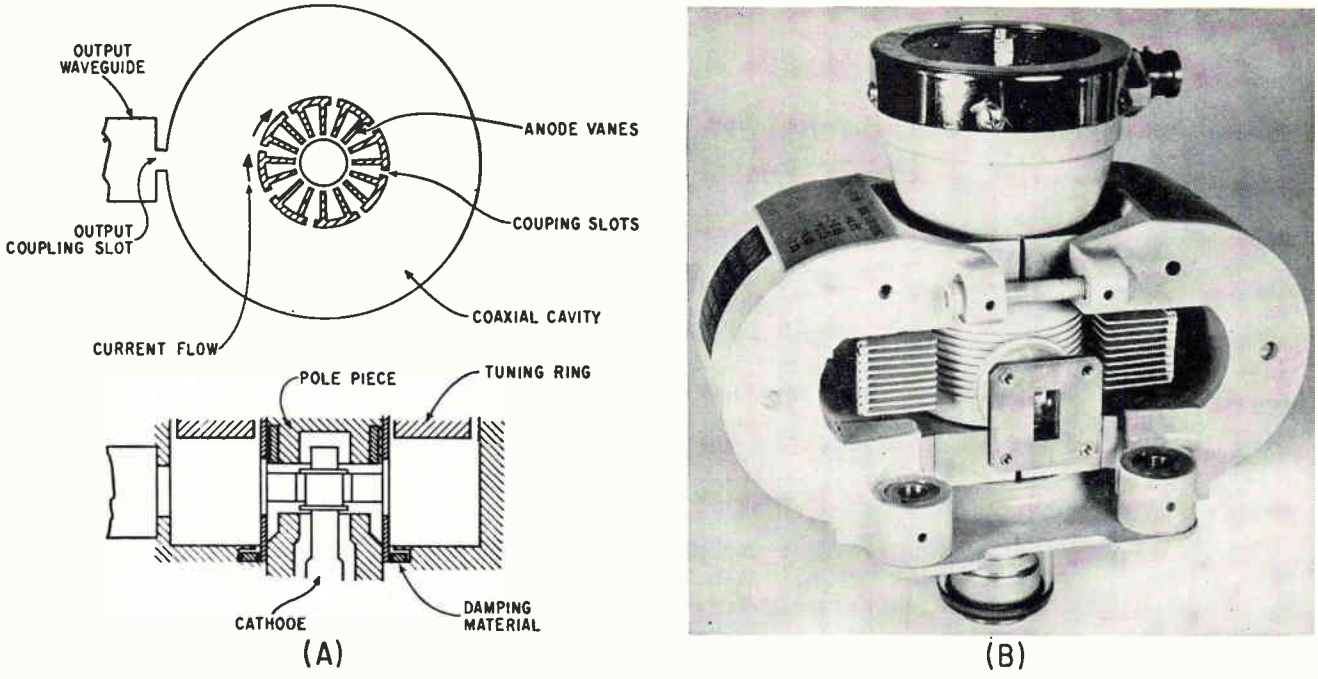


FIG. 1—Cross-sectional view of anode resonator geometry (A) with actual coaxial magnetron (B)

COAXIAL MAGNETRON

A New Microwave Power Source

High power output from tunable coaxial magnetrons makes long range K_u-band radar feasible. Wideband microwave generator also provides high frequency stability and simplified tuning

By H. M. OLSON
L. H. VON OHLSEN,
Bell Telephone Laboratories, Inc., Laureldale, Pennsylvania

NEW technique to control the oscillating mode of a magnetron has resulted in significantly improved frequency stability, power-generating efficiency and tuning range. Over a 2:1 range of input power, the operating frequency of the coaxial magnetron varies less than 0.001 percent. Output power of 125 Kw is generated at more than 40 percent efficiency over a range of 2,000 Mc.

The importance of the magnetron as a microwave electron device has been due to its ability to generate large amounts of pulse power. In developing this power capability to its utmost, the trend has been toward increasing the number of anode resonators arrayed around the cathode. As the complexity of this multicavity structure has grown, it has become increasingly difficult to restrict the electron interaction process to one of the many natural modes of the structure.

In the early years of magnetron development, two approaches to this mode control problem evolved. One involved strapping alternate resonators together while the other made use of rising-sun structures in which alternate resonators were of different sizes and different resonant frequencies. These schemes, which have become accepted as the conventional means of mode control, favor interaction with the mode characterized by a reversal of phase at each successive resonator around the array and is designated as the π mode.

More recently another method for mode control[1] has been conceived and perfected at the Bell Telephone Laboratories. This technique has served as the basis for the develop-

ment of the coaxial magnetron.

The new method of mode control is best described by contrasting it with strapping. In strapping, points of high r-f voltage that have identical phases in the desired mode are tied together by conducting straps. In the new method, r-f currents are tightly coupled together rather than voltages at points of identical phase in the desired mode.

The sketch in Fig. 1 shows anode resonator geometry. The high-current points are at the closed ends of the cavities formed between the vanes. The counterpart of the strap is the current flowing circumferentially around the center post and the outer circumference of the central cavities of a coaxial cavity excited in the circular electric (TE_{011}) mode. The amplitude and phase of this current is the same at all points around the center post of the cavity. Thus, by coupling the currents of every other vane cavity to the current of the circular electric mode of a coaxial cavity, the oscillation of the magnetron in the π mode produces excitation of the circular electric mode in the coaxial cavity. The currents of the vane structure are coupled to currents of the coaxial cavity by arranging the vane array inside the center post of the coaxial cavity and cutting slots through the closed ends of alternate vane cavities. This causes the currents established in the vane array to flow out onto the center post of the coaxial cavity. Other modes of the vanes, as well as the π mode, couple to modes of the coaxial cavity, just as in the strapped magnetron the strapping does not prevent the existence of the other vane modes. Instead, both schemes of mode control widen the separation between the frequencies of the various modes. This simplifies the problem of obtaining interaction with a particular mode by making it possible to selectively synchronize the electron stream with the fields of the desired mode only.

Since energy storage occurs in different parts of the coaxial cavity for various modes, it is possible to damp selectively undesired modes of oscillation with strategically placed microwave absorbing material. This affords a further advantage in mode control since it favors starting oscillation in the relatively undamped π mode.

Two by-products of incorporating the coaxial cavity into the magnetron for mode control are simplified tuning and greater frequency stability. Instead of tuning each vane cavity individually, only the coaxial cavity need be tuned. Tuning is done by making one of the end walls movable as in a cavity wavemeter. The threefold increase in oscillating frequency stability against changes in load or input power is due to the additional energy stored in the coaxial cavity.

This construction also yields a more efficient electronic interaction process by eliminating the straps or other discontinuities that distort the fields in the interaction region. The improved interaction more than compensates losses in the coaxial cavity so that overall the coaxial design is more efficient than conventional designs.

Three tunable coaxial magnetrons using these principles have been developed. Together they cover the frequency range of 13.6 to 19.5 Gc. These magnetrons are coded the 7976, 7208B, and 8079 and are suitable for both ground-based and airborne applications.

The 7208B magnetron, which is typical of the three, is shown in Fig. 1. This tube is mechanically tunable over the frequency range from 15.5 to 17.5 Gc. This range is larger by a factor of 2 than that obtained from available conventional magnetrons. The coaxial cavity design permits an internal Q of about 4,000, which is about five times better than that obtainable from magnetrons of conventional design in this frequency range. In addition, the coaxial cavity design results in only a small variation of internal Q as the tube is tuned throughout its frequency range. Thus the 7208B magnetron operates at an overall efficiency of better than 40 percent with less than a 20-percent variation in power output across the 2,000-Mc operating band. Power output at a 0.001 duty cycle as function of frequency is shown in Fig. 2A for operation at pulse lengths of both 0.1 and 3.0 microseconds. For comparison, lines of constant efficiency are shown in the same figure. Power output is flat and varies smoothly across the operating band without discontinuities. The 7208B is rated at more than 125 Kw of power output at a 0.001 duty cycle and for pulse lengths varying from 0.05 to 3 microseconds.

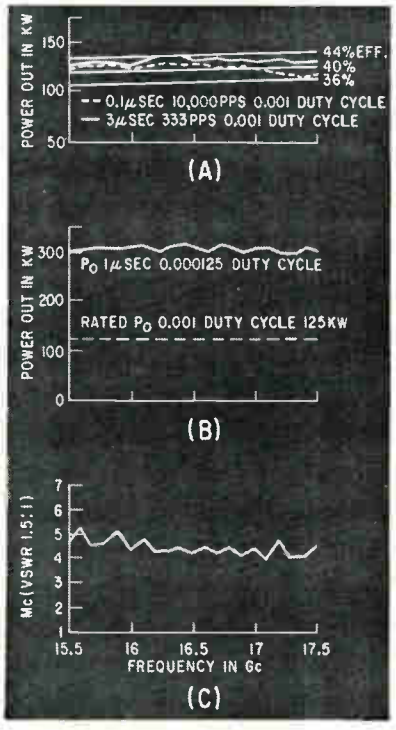


FIG. 2—Typical power characteristics (A) and (B) with pulling figure (C)

Operating at pulse lengths of one microsecond, power output greater than 300 Kw has been obtained over the frequency band, as shown in Fig. 2B. In conventional magnetrons operating over this frequency range, efficiencies of only 25 to 30 percent are obtained and power outputs are about one-half that of the 7208B.

The high frequency stability inherent in the coaxial cavity design is significantly improved over that of conventional designs. The pulling figure of the 7208B as a function of frequency is shown in Fig. 2C. This performance is better than that of conventional magnetrons by more than a factor of 3. The excellent frequency stability also results in excellent r-f spectrums.

The more than 125 Kw peak power available from these coaxial magnetrons makes relatively long-range Ku-band radars feasible. Increasing radar operating frequency can improve target resolution. In the absence of atmospheric attenuation and for constant power output, antenna size and receiver performance, radar range would be

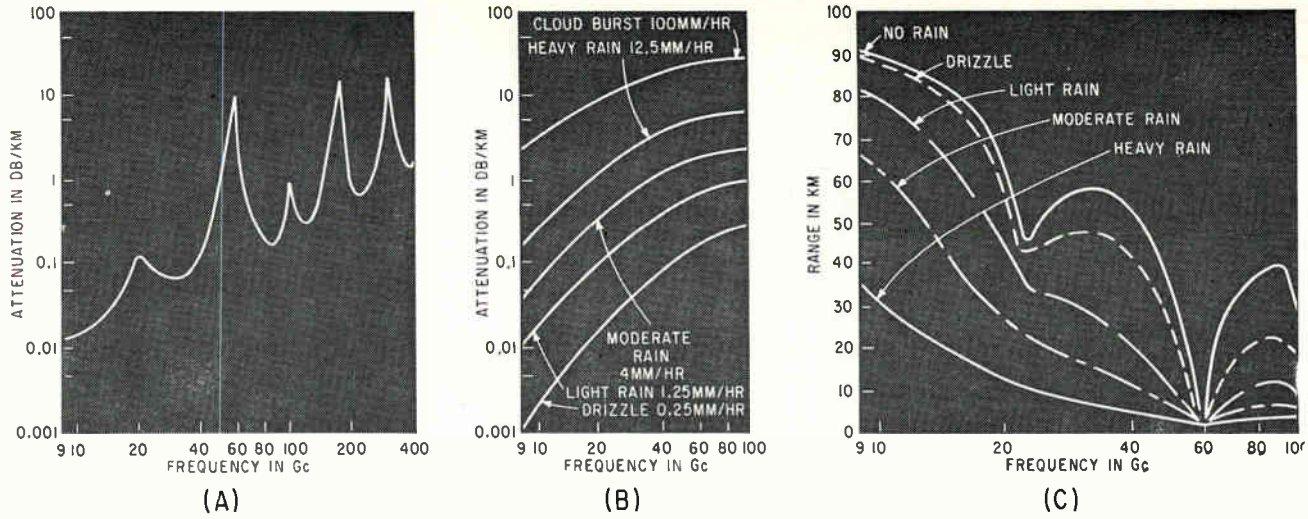


FIG. 3—Oxygen and water vapor attenuation (A), rain attenuation (B) and radar range (C)

independent of frequency. Unfortunately, atmospheric absorption cannot be ignored, particularly as the millimeter region is approached. Here attenuation resulting from absorption by water and oxygen molecules in the atmosphere and scattering caused by rainfall become serious. A study, by Van Vleck[2,3], Tolbert, Straiton[4], and others, of microwave absorption by oxygen and water vapor has resulted in an estimate of attenuation as a function of frequency. A curve depicting this attenuation is shown in Fig. 3A. The estimated attenuation caused by precipitation is based on the work of Haddock[5] and is reproduced in Fig. 3B for five rates of rainfall. The effects of these atmospheric attenuations on radar range as a function of frequency is shown in Fig. 3C with several precipitation rates as parameters. The curves were developed by assuming a modest group of design parameters that would result in a range of 100 kilometers (62 miles) in the absence of atmospheric attenuation. Although windows appear in the atmospheric absorption spectrum at Ka and W bands in the absence of rainfall, these windows almost completely disappear at modest rainfalls. The atmospheric attenuation effects become more serious as attempts are made to improve radar performance. For instance, if the 100-kilometer range in the example chosen were doubled by a 16 fold increase in the power radiated, a 71-percent range improvement would result at X band, 52-percent at Ku band, 32-percent at Ka band and only 20-percent at W band in light rainfall.

The Ku band offers a good compromise between target resolution and range deterioration from atmospheric losses. To obtain modest radar range performance for radars located near the earths' surface under inclement weather, Ku band represents the upper limit of practical operating frequency.

By scaling a particular geometry either up or down in size, it is possible to design coaxial magnetrons for other frequency ranges. The change in size is accompanied by a change in power handling ability and some change in efficiency. However, the power handling capability can be varied at a particular frequency by varying the number of vane resonators in proportion to the power required.

Several factors complicate the design. For example, the power output that can be derived from a magnetron depends on the operating conditions. The 7208 coaxial magnetron can be operated satisfactorily at more than three times its rated power under favorable pulse conditions. Moreover, despite the advantage gained in mode control from the coaxial design, the problem of obtaining stable operation in the π mode will become more difficult as the number of vane resonators is increased. Operating efficiency tends to decrease as the size of the tube is reduced. However, these are the kind of problems normally encountered in any microwave tube development and there are strong potentialities for higher power and frequencies in the coaxial principle of magnetron design.

The 7208B coaxial magnetron tunes over about a 12-percent band. The band is limited by the mechanical design of the tuner drive and by interfering resonances in the magnetron resonant structure just outside the band. However, the tuning range capability of the coaxial design is much greater. Using improved designs, the tuning range has been extended to 20 percent and designs in development are expected to have more than a 30-percent tuning range. The ultimate limit to the tuning range arises from the disparity in the natural resonance frequencies between the vane resonators and the coaxial cavity. As the coaxial cavity is tuned farther from the resonance frequency of the vane resonators, interaction between resonator fields and the electron stream will become weaker. Whatever the practical limit, exploiting the full capabilities of tuning range in the coaxial magnetron, a device will result that is adaptable to many applications.

This article is based on a paper presented at 1961 Wescon.

REFERENCES

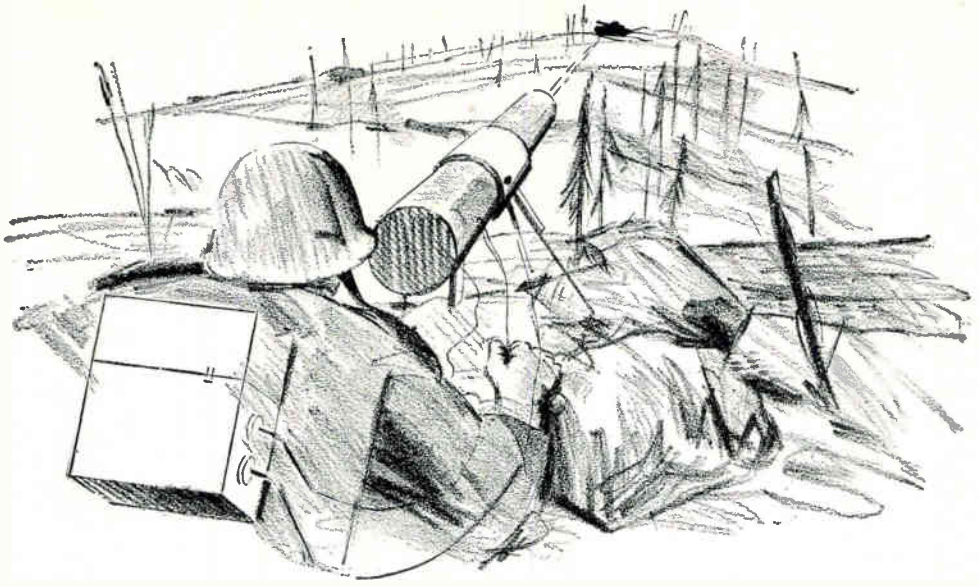
(1) J. Feinstein and R. J. Collier, A Magnetron Controlled by a Symmetrically-Coupled TE_{011} Mode Cavity, *Le Vide*, 70, p. 247, July-August 1957.

(2) J. H. Van Vleck, The Absorption of Microwaves by Oxygen, *Phys Rev*, 71, p. 413, April 1947.

(3) J. H. Van Vleck, The Absorption of Microwaves by Uncondensed Water Vapor, *Phys Rev*, 71, p. 425, April 1947.

(4) A. W. Straiton and C. W. Tolbert, An Analysis of Recent Measurements of the Atmospheric Absorption of Millimeter Radio Waves, *Proc IRE*, 49, Nov. 3, p. 649.

(5) F. T. Haddock, Scattering and Attenuation of Microwave Radiation Through Rain, Report of NRL Progress, June 1956.



Tactical operation of surveillance unit, which comprises a gas laser and receiving apparatus (Martin-Orlando)

LASERS:

DEVICES AND SYSTEMS-PART III

Applications of lasers to military and computing fields and ideas on frequency variation, modulation, demodulation and mixing

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

MILITARY APPLICATIONS of the laser go beyond ranging, communications and undersea warfare.[1] An application of the laser that admits to extensive speculation is a heat beam for military weapon use. Colloquially known as a death ray, such military devices fall into two groups: antipersonnel and antimachine, the last for destroying missiles, planes and tanks.

When the ruby laser was announced in 1960, uses such as these were speculated upon. Many scientific and engineering experts familiar with laser properties continue to speak about the possibility of developing such weapons. Further, some have suggested that Eastern block nations may be active in this work.

The highly collimated beam of infrared light generated by a laser can be focused to produce intense heat. In an experiment at Bell Laboratories, a laser beam was directed at a carbon block and focused with a simple lens. A spot on the target was heated to 8,000 C in only 0.5 millisecond.

A high-power laser built by the Trident Corp., has vaporized carbon, leaving craters on a carbon plate in tens of microseconds. The laser firing rate is 4 per second. Focal length of the projection system is short.

There has been mention in the literature of burning holes in thin steel by focused laser beams.

To achieve distant operation, techniques must be worked out to focus the beam selectively at any point up to the maximum range of the weapon. In using the device as an antimissile intercept unit, a means of tracking accurately a precise spot on the target must also be provided. There is also the problem of attenuation of the beam by the atmosphere in operating from an earth installation.

To overcome this it may be practical to locate an antimissile kill system in an orbiting space station, controlled from the earth. The sur-

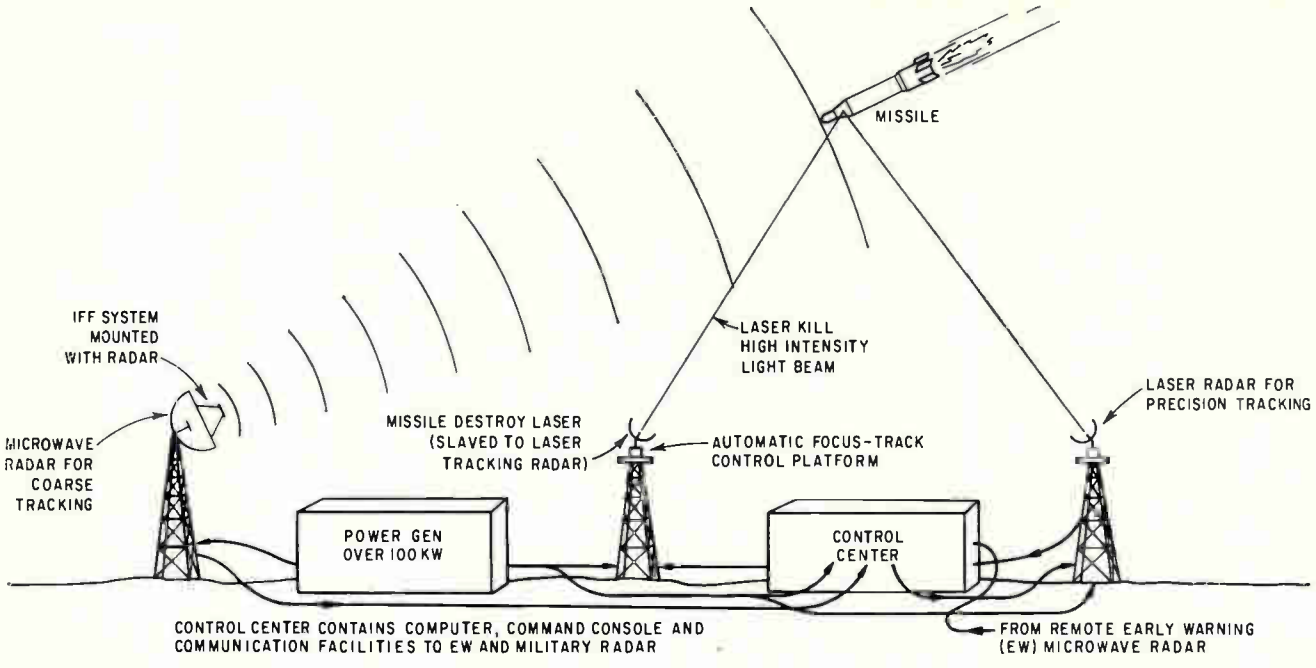


FIG. 1—Antimissile system shows how lasers might be used to track and destroy missiles

veillance area open to a laser beam originating from a point in space is much greater than achieved with a ground station. Another approach would include a laser in an antimissile missile, fired into space when required.

The means of destroying the missile might depend on burning a hole, however thin, through an important support member of the missile's frame. There are locations on an airframe where severe vibration will develop if a guiding vane is fractured. One can depend on disintegration of the major sensitive portions of the missile in this manner.

A complete earth-based laser kill system would include an acquisition center with inputs from early-warning radar and a microwave tracking radar to provide rough position information on the approaching missile. The tracking radar would align an optical radar (using a laser for ranging) on the target (Fig. 1). This method is analagous to the astronomer's method of using a wide field telescope to locate a star for study with a high-power narrow-field telescope.

The optical radar would provide precision tracking and range data to another laser unit that does the actual target burning. It will focus and train the kill laser on a vulnerable point, and hold it there long enough for burning. A high-speed servo system, and a complex focusing system must be developed to take advantage of the laser's potential in antimissile weaponry.

It would not be necessary to identify decoys, since a laser could account for many enemy missiles and decoys in a short time. However, an identification friend-or-foe system would be included to avoid attacking friendly vehicles.

It has been suggested that a liquid laser operating in the near infrared range is possible in theory, using the action of two chemicals and nothing else—to produce coherent light output. This has raised speculation about a "squirt-gun" like device to be used as a side arm by personnel. It might include a chamber containing one of the chemicals, with a lens ahead of the output area of this chamber. A second chemical would be pumped into the first chamber by trigger operation of a miniature pump. When the two liquids combine, an output focused to a fine point on the target by the lens would develop the heat required for use as a weapon.

An alternate might be a solid-state laser with battery power supply to operate the excitation light source. Since peak power is of major interest, the short duty cycle would allow design of compact side arms.

Other tactical uses of the laser are ranging and surveillance radar units operating at infrared and optical wavelengths. It has been suggested that the detail possible with optical radars will allow outline delineation of the target. Use of such equipment may be limited to clear weather. Use of infrared frequencies could maintain secrecy of operation against the observing eye of a battlefield soldier; unless he is equipped with ir detectors.

Optical computers that would use laser memory sections may be developed.[2] Such computers might operate at higher speeds than computers using wires or microwave plumbing to transmit information within the computer. Light guides such as optical fibers would transmit information that would be free from noise and cross talk between transmission lines. A laser memory section could provide fast switching times, since transition times between energy levels can be in the order of 10^{-9} sec or less.

Figure 2 shows a possible memory configuration that uses two lasers as a memory unit.[2] The pumping sources bring the lasers near, but not into, stimulated-emission. A write pulse puts a ONE into cell No. 1 by raising enough atoms to the level at which stimulated emission begins. The nondestructive readout line senses only the stimulated emission produced by cell No. 1, since the narrowband filter passes optical energy of only the stimulated-emission frequency and spon-

taneous radiation at this frequency is too weak to be sensed. Stimulated-emission light also goes to cell No. 2. After the write pulse, the stimulated emission produced by cell No. 1 decays towards zero.

A short time after the write pulse goes to cell No. 1, a rewrite pulse goes to cell No. 2 and, aided by the transferred input from cell No. 1, produces stimulated emission in cell No. 2. A transfer line circulates enough of cell No. 2's emission back to cell No. 1 to return cell No. 1 to its condition of strong stimulated emission. Thus, the recirculation circuit preserves the ONE bit of information. The ONE can be erased by omitting a rewrite pulse. A ZERO is represented by the absence of a write pulse. The memory unit can store a ZERO since cell No. 1 does not go into stimulated-emission if it does not receive a write pulse, and cell No. 2 does not produce stimulated emission unless it receives a ONE light pulse from cell No. 1.

Among other proposed laser-memory ideas[2] are: prohibiting transitions between energy levels by applying external electrical or/and magnetic fields to laser cells; using an optical delay line of low attenuation, rather than a second laser cell and transfer lines, to circulate enough energy back to the laser cell to restore a ONE; and using a three or four energy-level laser to alternately store a bit of information between the pairs of energy levels.

Frequency tuning of a laser, that is, changing a laser's output wavelength, may be desirable in producing a beat frequency by mixing two laser beams; here it might be desirable to vary the frequency of one of the lasers, which could be used as a local oscillator.[3]

Lasers that produce several wavelengths simultaneously—the He-Ne and 0.5-percent-Cr^{+++} ruby lasers are examples of such lasers—could be designed as stepped-frequency generators by providing a filter system that selects the desired wavelength. Another way to select the output wavelength of the 0.5-percent Cr^{+++} ruby laser is to change its excitation power, since each of its output wavelengths appears at different lasing thresholds;[4, 5] hence, application of enough excitation power to equal only the lowest lasing threshold would select a desired wavelength.

Temperature variations can be used to vary the output wavelength of a laser. Figure 3 shows how the R_1 spectral output of a 0.05-percent Cr^{+++} ruby laser varies with temperature.[6] This graph indicates that if temperature could be stabilized at any desired operating point, the selected output could be any wavelength between 6.943 A to 6.947 A; this tuning range is 24 Gc.

The Zeeman or Stark effects, by which the application of a magnetic or electric field to a lasing material increases the number of output spectral lines, might be used to shift the operating frequency of a laser. In a recent experiment,[7] an electric field of 1.7×10^5 v per cm was applied in a direction parallel to the optic axis of a ruby; the field shifted the R_1-line output about 15 Gc.

Operating frequency of a laser might be changed by inverting the populations of a different pair of energy levels.[8] Changing the excitation could be a way to do this. Retuning the cavity might be necessary when the operating frequency is changed.

Changing the gas density of a gas laser is a possible way to shift frequencies.[9] A change of gas density varies light velocity, thus changing the resonating condition (mode) of the laser. Different pressures would produce different frequencies.

Frequency changing in a gas-laser system could be accomplished by exhausting one lasing gas, or gas combination, from the cavity and replacing it with another lasing gas, or gases.[10] The laser cavity would probably have to be returned.

Frequency multiplication of a ruby laser's 6,943-A output was demonstrated in a recent experiment.[11] A 1-msec laser output pulse of 3 joules was passed through a filter to eliminate lamp-excitation radiation and then applied to a quartz crystal. Output of the quartz, which has a nonlinear dielectric coefficient and is transparent to 6.943 A and to 3.472 A, was 3,472 A. This second harmonic was considerably weaker than the fundamental; theoretical calculations indicates that 2nd-harmonic output intensities can be, at best, 1 percent of the fundamental. Although coherency of the 2nd-harmonic output was not checked, it may be partly coherent.

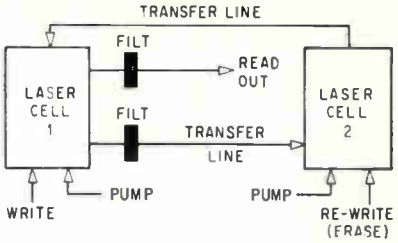


FIG. 2—Laser cells make up computer memory unit that can store one bit

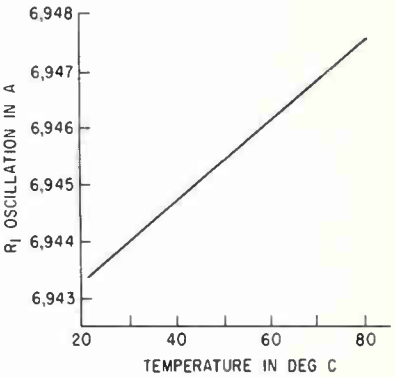


FIG. 3—Effect of ruby heating on ruby-laser output wavelength

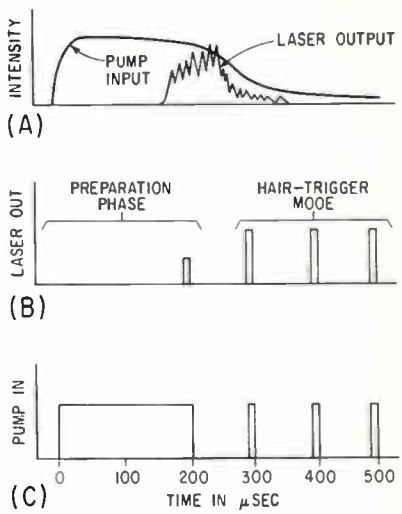


FIG. 4—Ruby laser output pulse (A) produced in conventional operation. Laser output pulses (B) are different, due to hair-trigger pumping (C)

Laser modulation techniques include internal and external modulation. Internal modulation modifies the laser carrier beam within the laser itself; external modulation modifies the laser carrier beam after it emerges from the laser.

One way to internally modulate

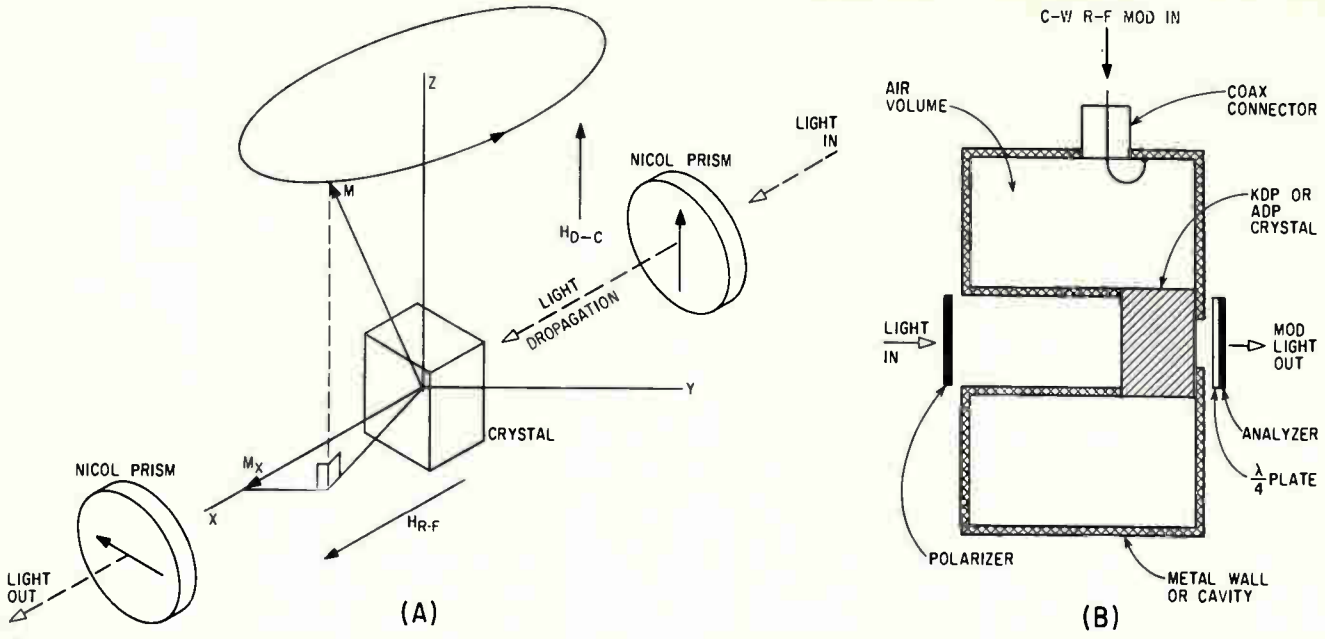


FIG. 5—Light modulation with magnetic field variation (A). Modulator (B) uses electric field (Sperry Gyroscope)

the laser is to modulate its excitation power. This method may be suitable for pulse modulation.

Up to now, pulsed-laser equipments that have used this method of modulation have switched the excitation source on and off. Their prf's have been low, in the order of several pulses per minute. A typical on-off equipment is a ranging system that provides a rectangular excitation pulse to a ruby-laser transmitter; the target reflects the light pulse back to the ranging receiver, which indicates the distance to target.[1, 12]

A recently proposed triggering method would increase prf rates of ruby lasers, as well as decrease pulse jitter.[13] Instead of switching the laser-excitation source fully ON to make the ruby lase, which is the conventional method indicated in Fig. 4A, just enough excitation is applied to barely start laser action (Fig. 4B and 4C). The low-amplitude pulse in Fig. 4B indicates the onset of laser action. Immediately after laser action begins, the excitation source goes off and laser action stops. At this time there are a large number of ions in a high-energy state; since the relaxation time between the upper state (the E-level) and the ground state is in the order of several msec, a relatively weak excitation pulse can restart laser action. About 100-μsec later, another excitation source applies a short-duration light pulse of low-energy to the ruby, causing it to lase. Pulses that follow at 100-μsec intervals provide a prf of 10^4 pps, with little jitter. The experimental laser that demonstrated this hair-trigger mode of operation encircles the ruby with two spiral and coaxial flashtubes. The smaller inner tube provides the trigger-excitation pulses and the larger tube, which surrounds the inner flash as well as the ruby, provides the 200-μsec preparation pulse.

High rates of information transmission may be achieved with a proposed internal-modulation technique that would use either ppm (pulse-position modulation) or ppm and/or pam (pulse-amplitude modulation).[14] Enough pumping power would be applied to a laser to make it lase, though not so much that laser action would be at a maximum. Thus, the number of excited molecules (that is, ions, atoms or molecules) would not be equal to the maximum possible number, that is, the saturation number. Application of partially coherent, or coherent, modulation light pulses to the laser would then increase the laser output. A ppm input would modulate a laser at approximately the maximum information-transmission rate possible for pulse-modulated lasers. Pulse-amplitude modulation can be combined with ppm by using low enough pump and input-excitation levels to prevent laser saturation.

The Stark and Zeeman effects may be used to modulate lasers internally. In using the Stark effect to modulate a ruby laser, a strong electric field would be applied to the ruby.[15] Ruby energy levels would be shifted, the shifts being dependent on the strength of the modulating electric field. Thus, microwave modulation of the field produces a frequency modulated light output. However, delivering sufficient excitation radiation to the ruby, which must be placed in a microwave cavity or waveguide, may be difficult.

Ultrasonic variation of crystal stress might be used to internally modulate solid-state lasing materials.[16] Laser heating would have to be minimized since heat affects crystal stress.

External modulation of a laser takes place in a modulation material that is placed in the path of the beam emerging from the laser. Solids show more promise as modulating materials than liquids or gases.[17] Acoustic, magnetic and electric effects on various materials can be used to modulate light.[17] The maximum modulation frequency when an acoustic wave modulates a crystal is in the order of 10 Gc.

There are several magnetic effects that can be used to modulate light.[17] The Faraday effect is the strongest of these magneto-optic effects. Figure 5A illustrates the

application of the Faraday effect to modulate a crystal. If magnetic field $H_{d\text{-}c}$ and $H_{r\text{-}f}$ are not present, the Nicol prism at the left of Fig. 5A will not pass light. Application of a magnetic field rotates the light's plane of polarization and produces a light output. The d-c field ($H_{d\text{-}c}$) causes the paramagnetic ions to have a resonant frequency. The sinusoidal r-f field ($H_{r\text{-}f}$) causes magnetization vector M to swing out and precess, thus sinusoidally rotating the plane of polarization of the polarized light going into the crystal. Typical crystals using the Faraday effect have a resonant frequency of 15 Gc and a rotation in the order of minutes. Bandwidth is in the order of megacycles.

Figure 5B shows a modulator that uses the Kerr (electro-optic) effect.[18] The microwave cavity contains the crystal that is modulated. Although its normal operating range is 30 Mc to 1,000 Mc, it can modulate light at frequencies up to 15 Gc, though at a lower level of modulation than for the normal range of operation. The r-f can vary intensity of the light transmitted through the crystal from 0 to 100 percent. Normally, the r-f input level is set so that 50-percent of the light input is transmitted by the crystal. The c-w r-f may be either a-m or f-m. Modulation power is only a few watts.

Researchers are investigating another type of light modulator.[19] A strong electric field slightly modifies the energy-bands of semiconductor crystals such as amorphous selenium, cadmium selenide and selenium-tellurium mixtures. Modifying the energy bands shifts the optical-absorption edge to longer wavelengths. Thus, it may be possible to use an electrical field to modulate the optical absorption of semiconductors at above-microwave frequencies.

Demodulation and mixing are being developed for laser circuits. When a microwave-modulated laser light beam strikes the photocathode of a phototube detector, the phototube produces a microwave-modulated electron beam. Using r-f terminology, the light input is the modulated carrier, the microwave modulation corresponds to the video signal and the phototube corresponds to the crystal detector of an r-f receiver.[19] Applying a local-oscillator-laser light signal to the phototube detector makes the phototube correspond to the mixer of a superheterodyne receiver.

A recently developed phototube demodulates frequency-modulated light.[19] A prism converts the f-m light beam into rays having angles corresponding to the frequency dispersion. These rays fall on different spots on the photocathode face. The electron beam of the phototube converts the ray-position modulation into an electrical f-m signal.

A recent experiment[20] reproduced the microwave beat frequency between two light wavelengths, thus demonstrating the feasibility of mixing light beams to produce an r-f frequency.[1] Source of the light wavelengths was a ruby laser. The laser light was focused on the cathode of a 2,500-to-4,000 Mc traveling-wave tube (twt) that was modified for the experiment. Laser light produced a small photocurrent in the twt, which was superimposed on the twt's 300-μa beam current. The amplified output of the twt comprised signals of about 1,800, 2,402, 3,004, and 3,606 Mc. These signals are produced by the mixing of various ruby-laser wavelengths in the twt cathode.

Amplification of laser outputs has been reported by ruby and gas lasers.[3, 21] Figure 6 shows the experimental amplifier setup that demonstrated ruby-laser light gains up to a factor of two. The common trigger energizes both pumps. Output of the ruby laser at the left of the drawing is amplified by the ruby laser at the right. The rubies have 0.05 percent Cr^{+++} dopings and have the same construction, except for their ends. One silvered end of the ruby oscillator is opaque and the other silvered end allows 5-percent transmission; the ends of the ruby amplifier are untreated.

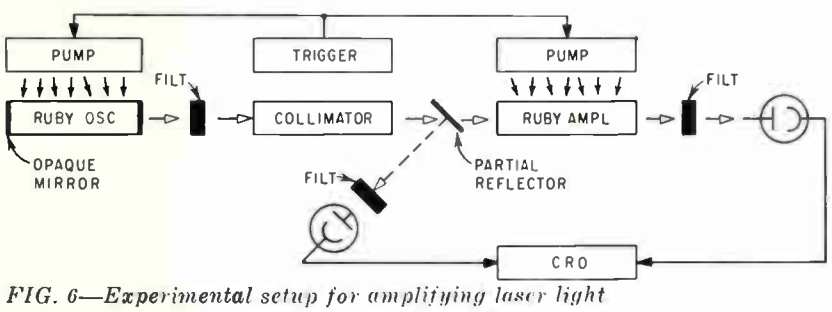


FIG. 6—Experimental setup for amplifying laser light

REFERENCES

(1) L. Dulberger and S. Vogel, Lasers: Devices and Systems, Part 2, ELECTRONICS, Nov. 3, 1961.
(2) L. C. Clapp, High Speed Optical Computers and Quantum Transition Memory Devices, West Joint Computer Conf., L. A., Cal., May 9, 1961.
(3) S. Vogel and L. Dulberger, Lasers: Devices and Systems, Part 1, ELECTRONICS, Oct. 27, 1961.
(4) A. L. Schawlow and G. E. Devlin, Simultaneous Optical Maser Action in Two Ruby Satellite Lines, *Phys Rev Lett*, 6, No. 3, p 96, Feb. 1, 1961.
(5) A. L. Schawlow, Optical Masers, *Sci Amer*, 204, No. 6, p 52, June, 1961.
(6) I. D. Abella and H. Z. Cummins, Thermal Tuning of Ruby Optical Maser, *J Appl Phys*, 32, No. 6, p 1, 177, June, 1961.
(7) W. Kaiser, S. Sugano and D. L. Wood, Splitting of the Emission Lines of Ruby by an External Electric Field, *Phys Rev Lett*, 6, No. 11, June 1, 1961.
(8) S. B. Collins, Sperry Gyroscope Div, Sperry Rand, Great Neck, N. Y., private commun.
(9) C. B. Ellis and I. A. Greenwood, Optical Masers in Space Navigation, 17th Annual Meeting of Inst of Navigation, Williamsburg, Va., June 30, 1961.
(10) M. Sidran, Grumman Aircraft Engineering Corp., Bethpage, N. Y., private commun.
(11) P. A. Franken, A. E. Hill, C. W. Peters, and G. Weinreich, Generation of Optical Harmonics, *Phys Rev Lett*, 7, No. 4, p 118, Aug. 15, 1961.
(12) E. J. Woodbury, R. S. Congleton, J. H. Morse and M. L. Stitch, Design and Operation of an Experimental Colidar, WESCON, San Francisco, Aug. 22, 1961.
(13) M. L. Stitch, E. J. Woodbury and J. H. Morse, Repetitive Hair-Trigger Mode of Optical Maser Operation, WESCON, San Francisco, Aug. 22, 1961.
(14) J. R. Singer and S. Wang, The Emission, Pulse-Level Inversion, and Modulation of Optical Masers, Second Int'l Conf on Quantum Electronics, Berkeley, Cal., Mar. 21, 1961.
(15) A. D. Kamal and S. D. Sims, Proposed Technique for Modulation of Coherent Light, *Proc IRE*, p 1,331, Aug., 1961.
(16) L. M. Vallese, IT & T, Nutley, N. J., private commun.
(17) P. S. Pershan and N. Bloembergen, Microwave Modulation of Light, Second Int'l Conf on Quantum Electronics, Berkeley, Cal., Mar. 21, 1961.
(18) R. Schneider and E. Stark, Sperry Gyroscope Div, Sperry Rand, Great Neck, N. Y., private commun.
(19) B. J. McMurtry, S. A. Harris and A. E. Siegman, Microwave Light Modulators and Demodulators, Review of Stanford Electronics Research, Aug. 15, 1961.
(20) B. J. McMurty and A. E. Siegman, Direct Observation of Microwave Frequency Beats due to Photomixing of Ruby Optical Maser Modes, Tech Report 177-1, Aug. 25, 1961, Electron Devices Lab, Stanford Electronics Laboratories, Stanford U, Stanford, Cal.
(21) P. P. Kisliuk and W. S. Boyle, The Pulsed Ruby Maser as a Light Amplifier, WESCON, San Francisco, Cal., Aug. 22, 1961.

Headsight Television System Provides Remote Surveillance

Surveillance of a remote area is possible with this unusual closed-circuit tv system. Miniature crt viewer is mounted on helmet worn by operator and camera at remote location follows operator's head motions

By CHARLES P. COMEAU
JAMES S. BRYAN,
Research Division, Philco Corp.,
Blue Bell, Pa.

HEADSIGHT is a closed-circuit television surveillance system in which the monitor is mounted on the forehead of an operator. This is done by light weight viewing optics similar to those used in this company's 2010L commercial portable television set. The 2010L uses a half silvered mirror combined with a section of a spherical mirror as shown in Fig. 1A to produce a virtual image of the face of a miniature, high-resolution crt. The effective image is 10 in. high, at a distance of 1½ feet from the observer, and is satisfactory from the standpoint of viewing comfort.

In the headsight system, similar light-weight optics and a similar miniature crt are mounted on a helmet so that the large virtual image is directly before the wearer's eyes. The viewing device moves with the operator's head motions, thus keeping the image of the crt directly in front of the operator's eyes. In addition, the helmet position controls smoothly and continuously the directional positioning of a remote vidicon television camera. The angle of view of the camera is adjusted to match exactly the angle subtended by the image seen by the helmeted observer. When the two angles are properly matched, all viewed objects appear to remain stationary as the camera pans past them. The net subjective effect is a sense of presence in the environment of the remote camera.

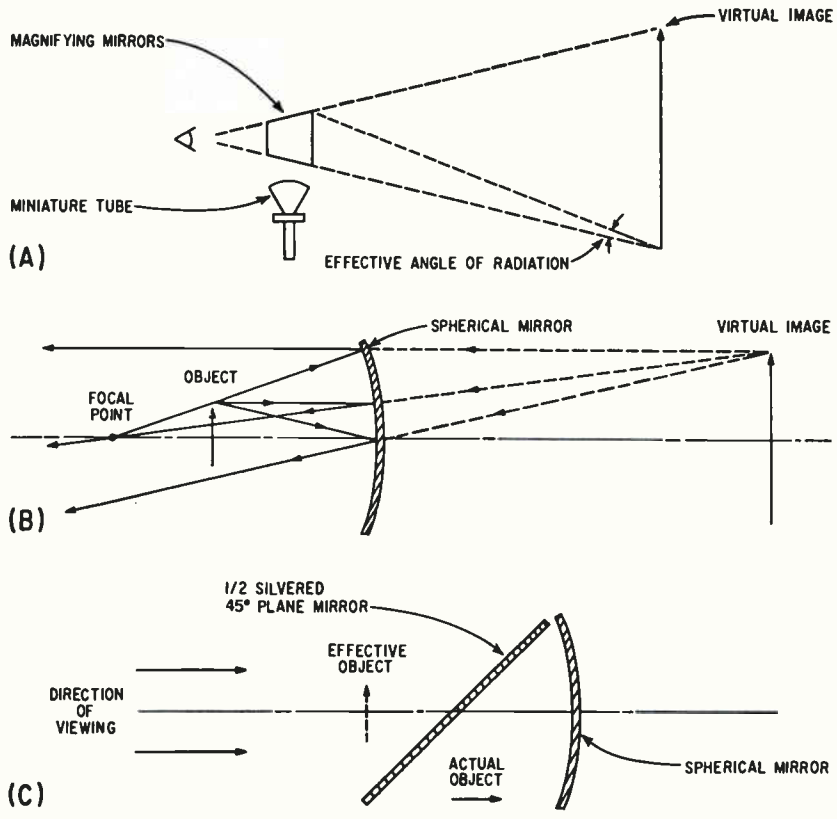


FIG. 1—Basic viewing optics for headsight system: miniature tube approach (A); typical reflective magnifier producing virtual image (B); and method of removing object from viewing path (C)

Wherever the operator points his head, right, left, up or down, the camera follows, viewing each portion of the scene in its correct relative position to the observer. If the observer tilts his head to one side the camera also tilts maintaining the viewed horizon at a constant level position. An operator, without any previous training, is able to follow rapid action from a distance and accurately relate the observations to the central point of camera reference. In addition, the operator's hands remain free to operate other controls.

To achieve the smooth and faithful following action of the camera required to create the illusion of presence, three servo motors position the camera in its three degrees of freedom, rotation (azimuth), nod (elevation and depression) and tilt (rotation about camera axis).

To supply the error signals to control the positioning servo

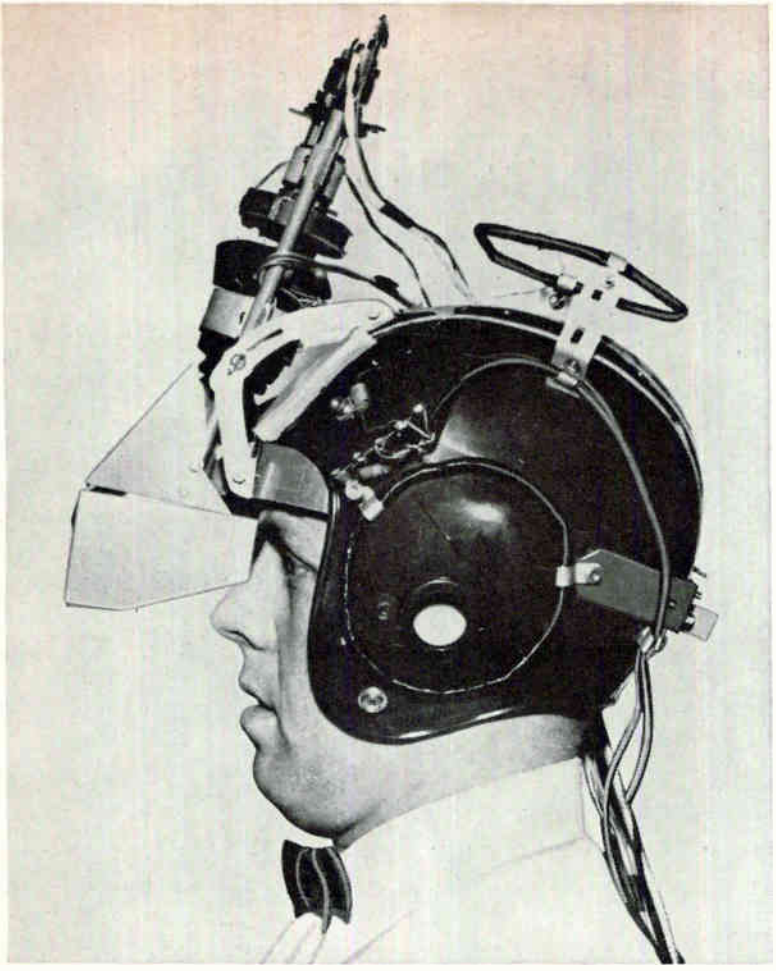


FIG. 2—Author Comeau demonstrates experimental model of the headsight viewer

motors, the camera and the observer are each placed in a set of identical magnetic fields which rotate at three different frequencies in three geometric planes (two vertical and one horizontal). These rotating magnetic fields then induce similar potentials in identical sets of position sensing coils placed atop the helmet and camera. The a-c potentials induced in these two sets of coils are phase compared to yield signals proportional to positioning errors in the three planes of magnetic rotation. Head motion is sensed without restricting the operator's freedom of motion and without adding significantly to the weight of the helmet. The camera positioning servo motors then keep always identically timed fields in the two sets of position-sensing coils, and all head motions are followed faithfully. The servo mechanism response times were so chosen that, after gross head motions, the camera always achieves equilibrium before eye fixation is complete.

Figure 1B illustrates the principle of the viewer mechanism. Objects closer to a spherical mirror than the focal point produce magnified virtual images. With a sufficiently large mirror surface, the virtual image may be viewed simultaneously with both eyes to produce the illusion of a large picture suspended in space a few feet from the observer. No image brightness need be lost in viewing, since the magnification is accomplished at the expense of directing the object light into a more limited viewing angle. The optical system permits a low-power television display by directing most of the light generated by the crt into a narrow beam suitable for a single viewer. So that the object itself might not interfere with the field of view, the optical system is folded as shown in Fig. 1C by means of a half silvered mirror. The mirror introduces light loss into the system but at the same time it protects the crt face from ambient illumination. With cathode currents of only 40 μa at 10 Kv, satisfactory viewing is possible, even in bright sunlight.

The cathode ray tube is unusual in that exceptional resolution is required in a small, light-weight package. A triode gun with permanent magnetic focus is used to achieve the small electron spot required. Figure 2 shows how the 2 pound crt assembly is worn by the operator. With this arrangement full 525 line television resolution was possible in the 1 in. $\times$ 1$\frac{1}{2}$ in. raster. Slightly modified designs would permit resolutions of 1,000 lines or better, and electrostatic focus could provide even further weight reduction.

In the camera, a vidicon tube is used because of its small size and light weight. Since the camera must move fast enough to follow the operator's head motion, it is important that the moment-of-inertia be kept low. The short compact camera package shown in Fig. 3 was designed to have a low moment-of-inertia about its three axes of rotation. Although the long persistance of image in a vidicon tube would seem to make it less desirable as a camera tube where fast moving objects are to be viewed, this persistance did not present a problem.

The camera preamplifier is mounted in front of the camera on a ring which surrounds the lens. This transistor amplifier increases the level of the video signal before it is transmitted through cables to the video display monitors. This placement of the preamp between the vidicon and the transmission lines results in satisfactory noise performance.

The duplication of head motion is accomplished by mounting the camera in motor driven gimbals. These gimbals simulate the neck and body motions of the operator.

Figure 4A shows a skeleton view of the servo motors and gear train. The camera is suspended on a yoke that can be rotated 360 degrees to generate the azimuth motion. This motion about the vertical axis is controlled by motor 3. This action duplicates the turning motion of the head, either at the neck, or the entire body rotation.

Motors #1 and #2 operate as a pair to generate the tilt and nod motions. If both motor shafts are rotated in the same direction, the camera will rotate about its prin-

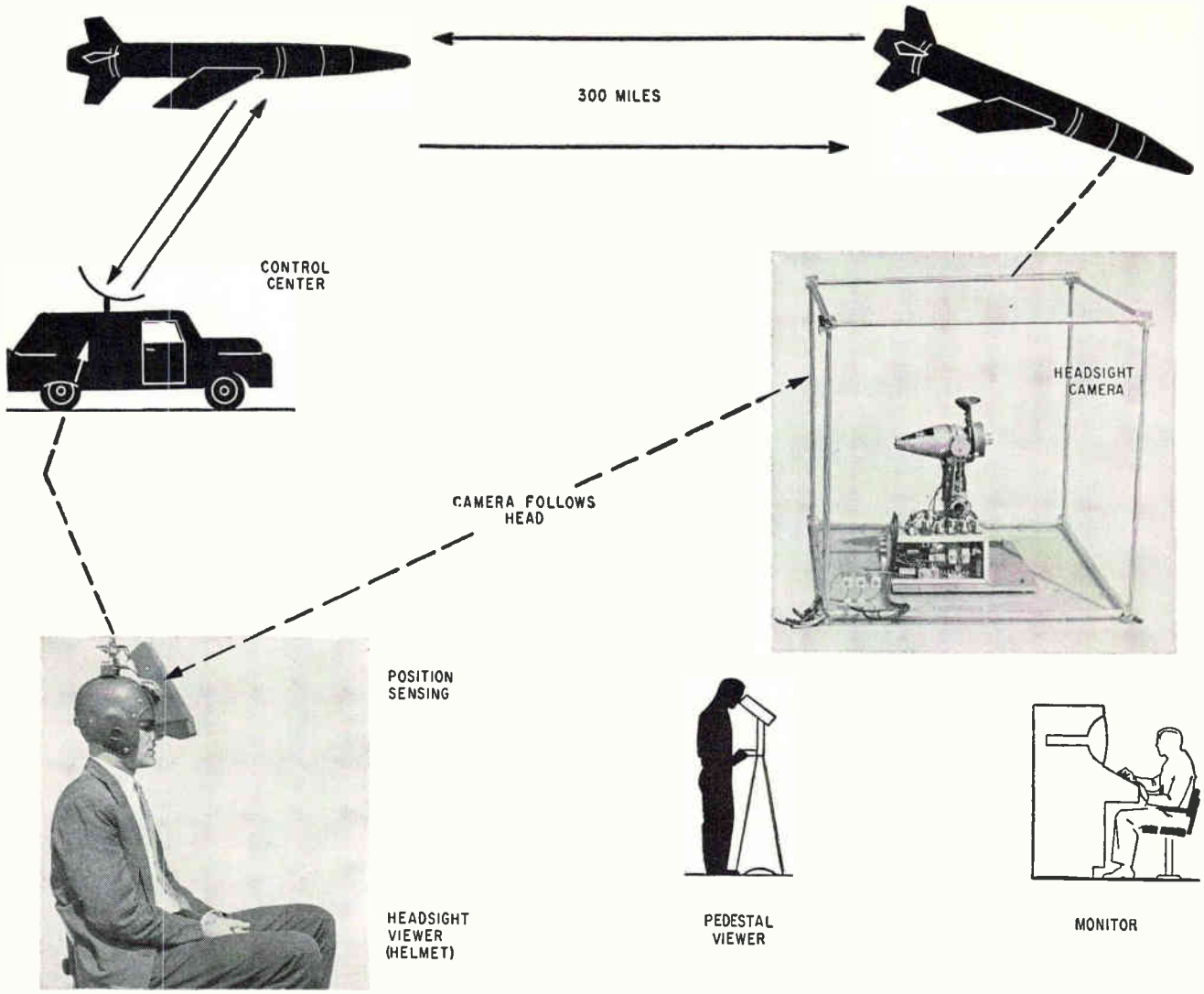


FIG. 3—Possible application of the headsight system is to mount camera in drone or rocket. The viewer, at home base, has the sense of being in the drone and can survey remote areas in complete safety

cipal axis, causing the picture to tilt (solid arrows in Fig. 4B). If both motor shafts are turning in opposite directions, the camera will tilt up or down, generating the motion called nod. This motion is shown by doted arrows in Fig. 4B. Both tilt and nod function simultaneously. This maintains a level, stationary horizon regardless of the position of the head.

The differential gear train that controls the tilt and nod motion results in a balanced, low-inertia package. The low moment-of-inertia, which is aided by the placement of all of the heavy components close to the vertical axis, minimizes the power requirement of motor No. 3. Since the force required to accelerate the camera in either the nod or tilt mode is shared by both motors 1 and 2, the power required for each motor is half of that which would be needed to perform the two tasks with separate independent motors. The ability to control tilt and nod independently is not compromised with this arrangement. Whenever the velocities of these two motors are not identical, they are performing the actions of tilt and nod simultaneously.

The head position sensing mechanism employs a pair of coils which is mounted rigidly on the operator's helmet, as in Fig. 3. An identical set of coils is mounted on top of the camera (Fig. 3). These coils are redrawn in Fig. 5. The coil wound in the vertical plane senses both the azimuth and nod position of the head. The horizontal coil senses the tilt of the head with respect to the viewed horizon.

The position detecting coils detect orientation by sensing the phase of three fields which are rotating in the direction of azimuth, nod and tilt. These fields are generated by large sets of Helmholtz coils placed in a cube around the observer. A second smaller but electrically identical set of coils surrounds the camera.

For sensing the position of any one of the three degrees of freedom, the fields generated by 2 pairs of coils are used. One pair of coils is connected directly to the signal generator. The phase of the signal in the second pair is shifted by 90 degrees to form a quadrature signal. The combination of the signals in the two pairs of coils forms a constant-amplitude field that rotates in space at ω_o, similar to the rotating fields in a two-phase induction motor. If the field generating coils are large, and of the proper geometric configuration, the phase and amplitude of the generated field will be essentially uniform everywhere within the space enclosed by the coils. Large coils

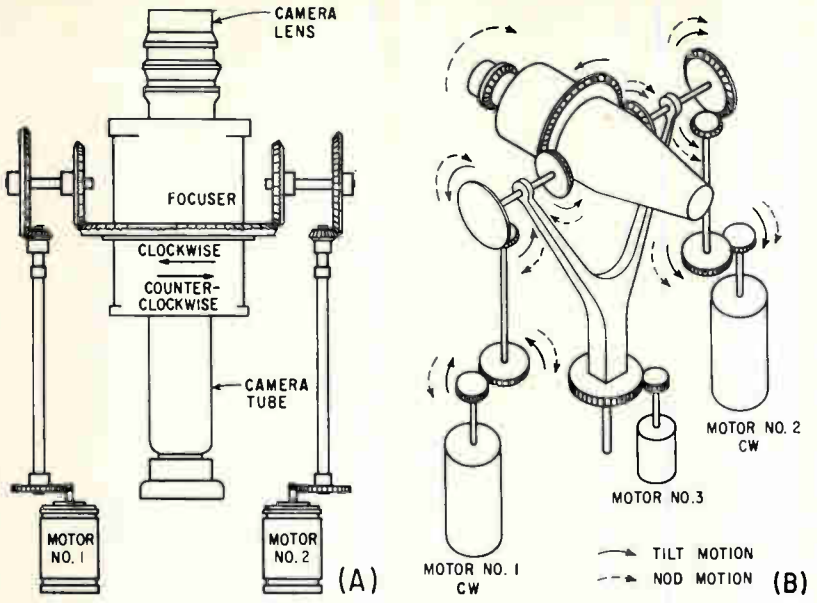


FIG. 4—Servo motors and gear train (A), and illustration of how tilt and nod motions are generated (B)

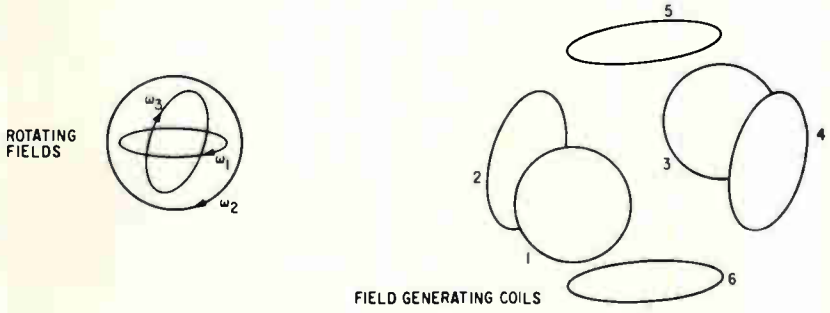


FIG. 5—Relationships of field generating coils (right), and rotating fields (left)

also have the advantage that they do not restrict the free movements of the operator within the room. The three independent rotating fields, ω_1, ω_2, and ω_3, are generated by three independent signal generators.

Figure 5 represents the three sets of coils needed to generate the rotating fields. Coils 1, 2, 3 and 4 are connected to a generator that generates a constant amplitude field rotating about a vertical axis at a rate ω_1.

In a similar manner, coils 1, 5, 3, 6 are connected to a second generator so as to produce a constant amplitude signal, ω_2, which is rotating about an axis normal to the paper. A third rotating field is generated by connecting coils 2, 5, 4 and 6 to form a field rotating about a horizontal axis parallel to the paper. The three rotating fields are at three different frequencies and act independently of each other.

A large set of the coils described above was built in the shape of a small square room in which the operator sits. The operator could move freely around the room without a sense of restriction. A similar, but much smaller, set of coils was placed around the camera. This set of coils can be observed in the cubic frame that surrounds the camera in Fig. 3.

On top of the camera is a small pair of coils used for detecting the three rotating fields. The phase of the signals induced in the sensing coils is directly related to the orientation of the sensing coil. Coil 1C (Fig. 6) is used for sensing the azimuth position of the camera. Since signal ω_1 is rotating about a vertical axis, the phase of ω_1 induced in coil 1C would depend on the orientation of coil 1C.

An identical pair of coils is placed on the helmet of the operator. These coils follow all the head motions of the operator. Coil 1H (Fig. 6) on the operator's helmet senses the phase of the signal (ω_1) generated by the azimuth coils surrounding the operator. If the operator is facing in exactly the same direction as the camera, the phase of ω_1 induced in the operator's coil 1H will be identical to the phase of the signal induced in the camera coil 1C. If the two coils are not facing in exactly the same direction, the phase of the current induced in the two coils will differ by an amount exactly equal to the angle between the head coil and the camera coil. When a phase error is detected, the high-gain servo amplifier energizes the servo motor, that rotates the camera reducing the phase error to zero.

The tilt and nod control work in a similar manner, by using the signals induced in coil 2C and 2H. When the camera is facing coil 2 or 4, the signal generated by coils 2, 5, 4 and 6 (see Fig. 5) control the motion of nod. However, when the camera azimuth is rotated by 90 degrees, the nod position will be controlled by the signal generated in coils 1, 5, 3, 6. The transition between the two signals that alternately control the nod position is made by the block called nod relay (Fig. 6). The nod relay is an electronic switch that slowly shifts the control signal as the head is rotated through the transistion points. The tilt relay (Fig. 6) performs a similar function for the tilt signals. The tilt and nod relay enable the camera to rotate through 360 degrees (azimuth) while the tilt and nod control is alternately shifted every 90 degrees.

Since the same two motors that control the nod position also control the tilt position, a passive matrix network (Fig. 6) adds or subtracts the error signals needed to drive the two motors. Both tilt and nod corrections can be made simultaneously without having the two operations interfere with each other.

The unit in Fig. 2 was built and tested to evaluate its operating characteristics. Further development of the viewer could easily achieve still further weight reduction, yet the weight of 2 lb including the helmet was not ob-

jectionable.

The operator was able to view and follow fast moving objects, such as might be seen at a tennis match. Even an untrained operator could follow the tennis ball precisely, after only a few moments of operation. The operator achieves this camera control through his head motions only. The same operations were attempted, using manual control of the camera position. Manual control of the camera proved to be more difficult and much less precise than the headsight control system.

The headsight system also allows an observer to view dangerous operations as if he were at the scene, and yet he can be far away. Typical situations might include explorations of ocean depths, space or radioactive areas; it might also be used in military combat surveillance.

A further variation can be added to the above headsight system that would improve the effective resolution without adding more weight, or using a larger cathode-ray tube. Since the viewed scene is always directly in front of the observer, the resolution pattern of the viewer can to some extent be made to match the resolution pattern of the human eye. Such a system would obtain improved resolution at the center of the crt at the expense of poorer resolution at the edge of the crt. This then would be similar to the high resolution obtainable in the fovia (central position) of the eye as compared to the decreased resolution toward the edges of the field of view of the eye.

The use of fovia-matched system resolutions would not lessen the system performance below that of a system that had high resolution over the entire raster. A normal stationary monitor would ordinarily need the high resolution performance over its entire raster to allow the observer to concentrate his attention on any portion of the included scene. The fovial headsight automatically moves the center of visual attention to the central high-resolution portion of the monitor. The use of the fovial headsight system would produce an image equivalent to that of a high resolution system with at least eighteen times the video bandwidth of the headsight approach.

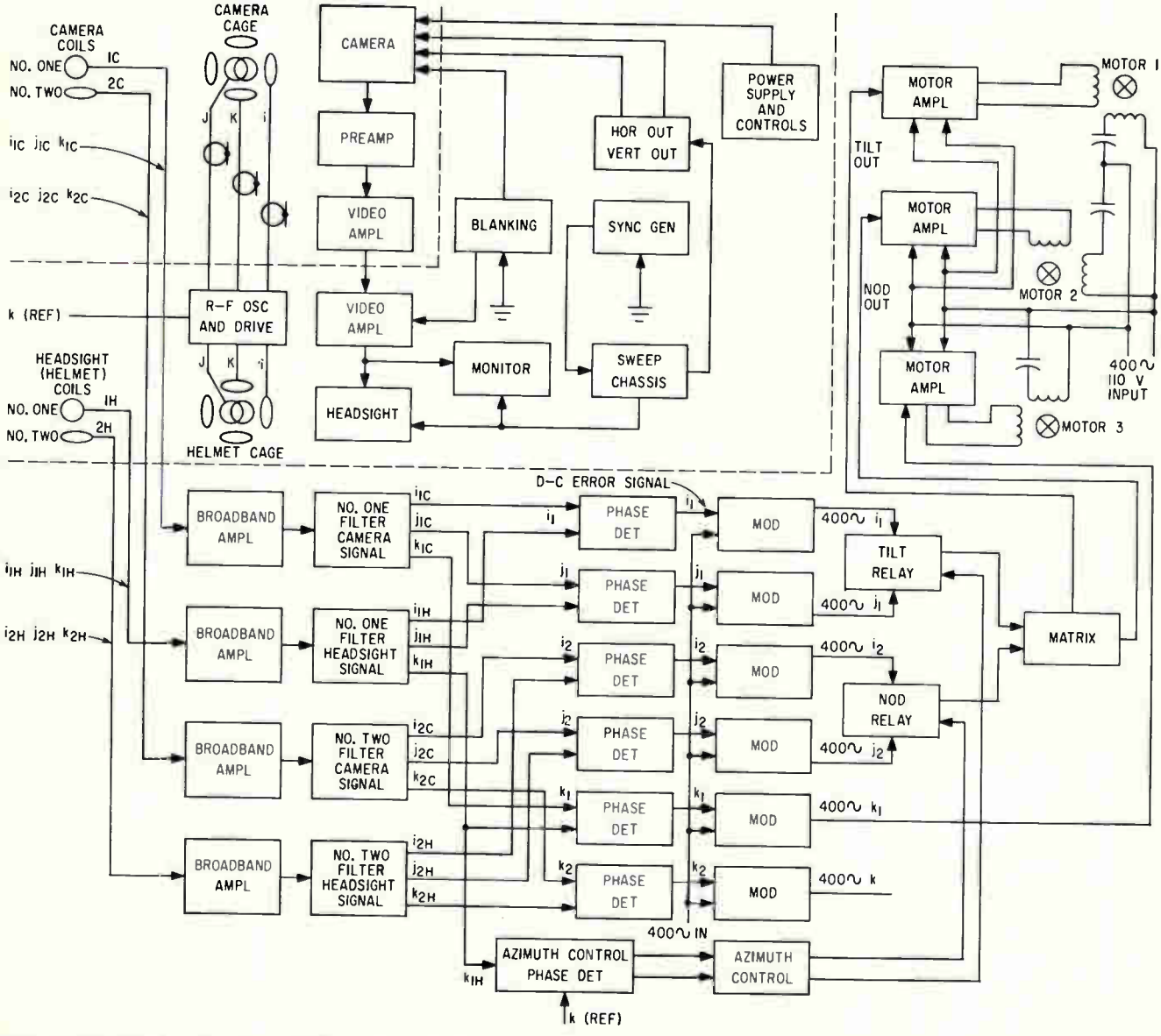
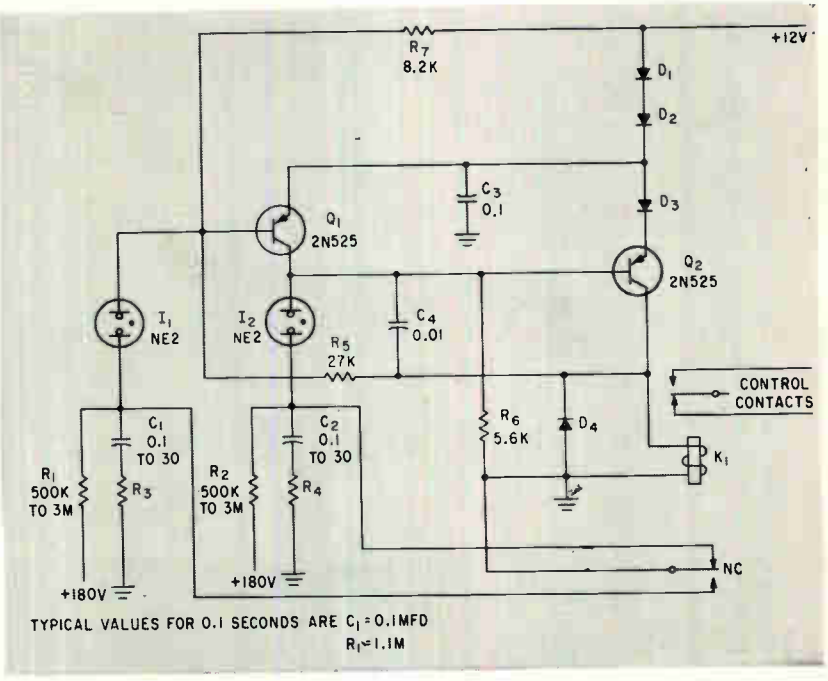


FIG. 6—Headsight television viewing and control systems. Coil IC senses azimuthal position of camera

BISTABLE CIRCUIT
Times Camera Exposures

Timer controls both exposure time and interval between exposures; has range from 0.1 second to 2 hours

By JOHN G. FULLERTON,
High Altitude Observatory,
University of Colorado,
Boulder, Colorado



Bistable circuit is so arranged that each half-cycle can be adjusted independently by changing time constants with capacitors C_1 and C_2

A SMALL, FLEXIBLE, preferably nonmechanical timer was required for controlling the exposure time and the interval between exposures of a data recording camera. Similar timers were to control calibration intervals of the associated experiment. Time intervals of exposure and between exposures had to be varied over wide ranges between 0.1 second and 2 hours, and had to be independent of each other. Such flexibility is not readily available in mechanical devices.

The time intervals are determined by RC time constants and latching of the circuit ON or OFF by a two-stage transistor circuit with feedback. The basic circuit is shown in the figure.

Consider the timer as being ON, that is Q_2 in conduction, K_1 energized, and Q_1 off. The timer is kept ON by current flowing through R_6 to the base of Q_2. Since Q_2 is saturated, the voltage at Q_2's collector is approximately 10 v. Since R_7 is tied positive with respect to Q_1's emitter, and the ratio of R_7 and R_5 keeps Q_1's base positive, Q_1 is turned off. When C_2 charges to about 80 v, I_2 will fire and turn Q_2 off. When Q_2's collector goes negative, enough current is supplied through R_5 to saturate Q_1; its collector pulls Q_2's base to cutoff. The cycle begins again when C_1 charges to about 80 v, lamp I_1 fires, and supplies current to turn off Q_1 and energize K_1. The forward conduction voltage drop of diodes D_1, D_2 and D_3 supplies proper bias for the circuit.

Capacitors C_1 and C_2 are charged from a 180-v supply to maintain the charge rate at a near linear value up to the point where I_1 and I_2 fire. The 180-v supply could be eliminated by substituting unijunction transistors or similar devices, such as 4-layer diodes, for neon lamps I_1 and I_2. Capacitors C_1 and C_2 could then be charged from the main power source. Mylar film capacitors are chosen for C_1 and C_2, to have low leakage. Leakage through semiconductor devices does limit the dynamic range of the timer and may limit the repeatability of time intervals due to temperature variations; for this reason gas discharge tubes were chosen because of their low leakage and consequent extension of the dynamic range.

While one capacitor is charging, the other capacitor is prevented from charging by relay contacts which ground its charging source. Current through the relay contacts and through the neon lamps and the base junctions of the transistors is limited by resistors in the ground return leads of the capacitors. Capacitors C_3 and C_4 supress transients from other sources which might falsely trigger the timer.

The values of C_1 and C_2, as well as R_1 and R_2, may be varied to give the timer great dynamic range. Speed of operation is primarily limited by the speed of the two-contact relay.

Credit is due to R. H. Lee for the basic concept of the timer and to the Office of Naval Research and The National Science Foundation for support of the experiment.

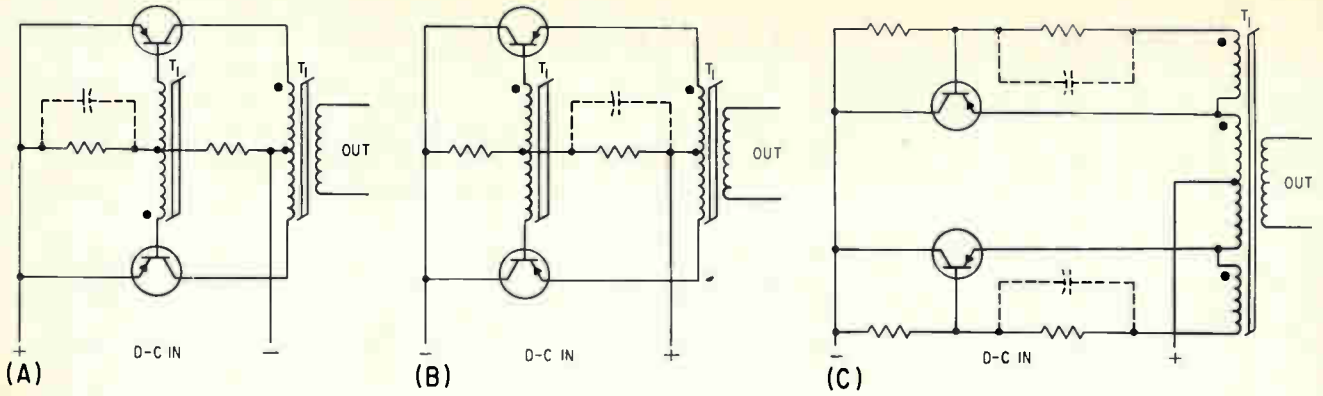


FIG. 1—Basic configurations of transistor inverter circuits are indicated by solid lines in (A), (B) and (C). Dotted lines show capacitors that are added to speed switching

SPEED-UP CIRCUITS IMPROVE

Switching of Transistor Inverters

Quickening switching speeds decreases transistor dissipation and lowers the ripple in the d-c produced by rectifying the inverter's output. Additional capacitors and transformer windings provide the increase in switching speed

By ALLAN G. LLOYD,
Bread-Boards, Inc., Newark, N. J.

INVERTER CIRCUITS such as those shown in Fig. 1 sometimes produce poor switching waveforms. Among the causes of poor switching is the use of very square hysteresis-loop core material having few primary turns (ten to twenty) per half. The resulting notches, steps or pauses produced during voltage reversals at switching cause excess transistor power dissipation and increased ripple of d-c produced by rectification of the inverter's output. High-power (100 watts and up), high-frequency (1,500 cps) germanium inverters with resistive loads are particularly prone to sluggish switching because there are usually only three or four turns on the feedback windings; the high-frequency loop gain, which is related to switching speed, is low. Magnetic saturation of the transformer core at the end of a half-cycle quickly forces the ON transistor to OFF, but turning on the OFF transistor requires sufficient energy return from the transformer to overcome the bias and turn-on time requirements of the OFF transistor. Also, time is required to sweep all the minority carriers from the ON transistor junction, and until this is done, the ON transistor constitutes an additional burden to turning on the OFF transistor. Figure 1 shows capacitors (dotted) that can be added to the basic inverter circuits to help switching. These capacitors are usually large-value electrolytics and frequently give only partial improvement of the switching waveforms.

Figure 2 shows circuits that produce better switching waveforms. In Fig. 2A base resistors R_1 and R_2 allow the addition of cross-coupled positive-feedback capacitors C_1 and C_2. These capacitors greatly increase the high-frequency gain of the feedback loop, and provide energy storage to drive the OFF transistor fully on when the core saturates. Each capacitor differentiates the square-wave output voltage and applies the positive and negative current spikes as additional positive feedback to the transistor bases during switching. There is an optimum value for these capacitors. Too small a value will have no effect. Too large a value may cause high frequency oscillations at no load, generate excessive base-emitter and base-collector voltage spikes, and load the inverter capacitively. Small resistors can be placed in series with each capacitor to modify the current spikes. Figure 2B shows a speed-up arrangement applied to the common collector circuit of Fig. 1B.

Figure 2C shows the Fig. 1C circuit modified with speed-up winding N_1 and capacitor C_1. The number of turns on N_1 is not critical but must exceed $(N_p + 2N_b)$. As N_1 is increased above this value, the required value of C_1 is reduced. Prac-

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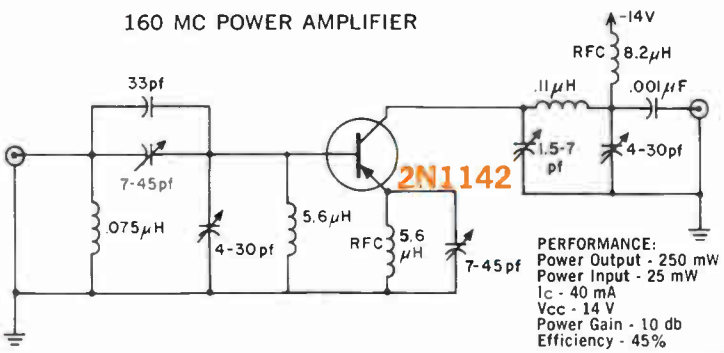

The latest devices to join Motorola's epitaxial mesa family are four new PNP germanium transistors, the 2N1141-2-3 and the 2N1195. These new Motorola communication amplifiers provide very high power gain and low R-F noise in the VHF-UHF frequency ranges. They not only make ideal drivers for 160 mc power mesas (Motorola 2N1692) in transmitter output stages, but they also solve critical design problems in frequency multipliers, R-F and I-F amplifiers, mixers, and oscillators.

In addition to higher power gain and lower R-F noise, the new epitaxial units also offer typically:

$V_{CE(sat)} = .185$ V @ $I_c = 50$ mA;
100 mc $h_{FE} = 18$ db.

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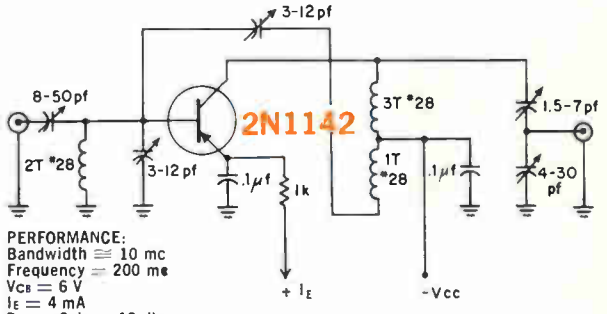
LOW NOISE 200 MC AMPLIFIER

5 db noise figure at 15 db power gain

And, this new Motorola 2N1141 series offers performance breakthroughs in the communication field for low-noise R-F circuits and broad-band high-frequency amplifiers. In front-end applications the low noise of this series provides new extended receiver range. A typical low noise, broad-band amplifier circuit is shown below.

LOW NOISE BROAD-BAND AMPLIFIER



PERFORMANCE:
Bandwidth ≅ 10 mc
Frequency = 200 mc
$V_{CB} = 6$ V
$I_E = 4$ mA
Power Gain = 15 db
Noise Figure = 5 db
Note all coils 3/16" ID air core

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tice shows that $N_1 = 2N_p$ works well. The v-a rating of N_1 is small because the speed-up current flows only during switching and has a very low rms value. Capacitor C_1 is nonpolar. Production tolerance can be taken care of by making C_1 twice as large as necessary for adequate switching and clipping the resulting base-collector voltage spikes with despiking network D_1, D_2, C_2, R_3.

Figure 2D shows speed-up windings individually applied to each base circuit. Figure 2E shows a speed-up arrangement for a silicon transistor. Such transistors have a low value of allowable reverse base-emitter voltage. Diode D_1 limits negative-drive excursions, and D_2 uncouples base resistor R_1 from the positive-current spikes coming from C_1 during turn-on. Resistor R_2 supplies a path for I_{co} during the OFF period.

Figure 2F shows the base-drive two-generator equivalent circuit. Here, the speed-up voltage (E_1) is 24 v and the drive voltage (E_2) is 3 v. In Fig. 2G, generator E_2 and R_1 are replaced by their Thevenin-circuit equivalents, using E_1 as the source. This results in $R_2 = 24$ ohms and $R_1 = 3.43$ ohms. However, an extra 24 watts of power loss is incurred in R_2 as a result of this configuration, so that the price of using a single high-voltage winding for both speed-up and base drive is gross inefficiency. Otherwise, the circuits of Fig. 2F and 2G have the same performance.

These speed-up circuits allow inverters to switch at the highest possible speed without sacrificing large amounts of power in base-drive resistors. Switching times of 4 microseconds have been observed for 2N174's and 2 microseconds for some types of germanium power transistors.

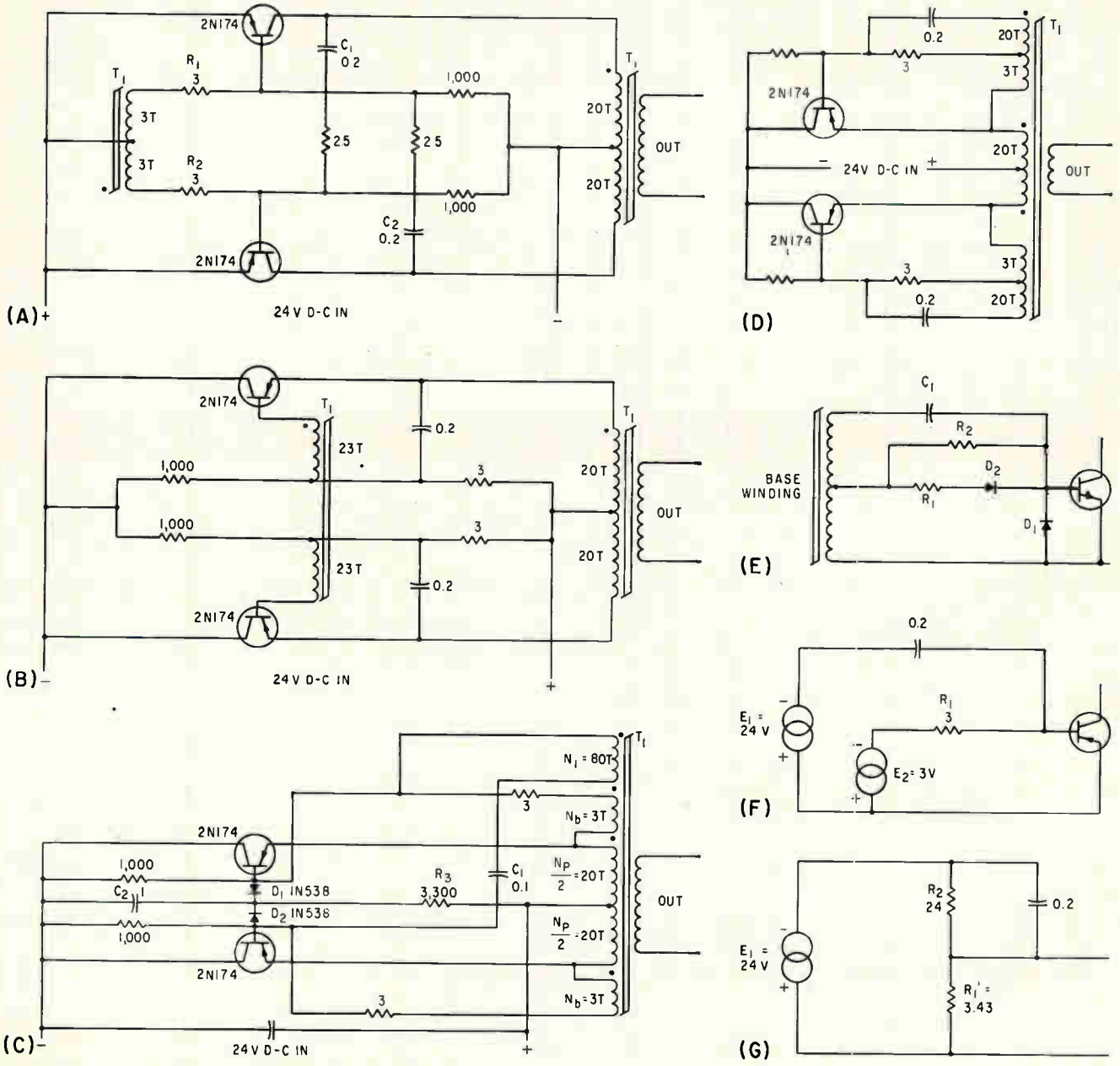

FIG. 2—Circuits (A) through (D) show complete configurations having fast switching. Circuit (E) indicates modification of (D) for a silicon transistor. Equivalent circuit (F) has two base-drive sources, as do (D) and (E). Equivalent circuit (G) produces two base drives from a single source

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Cryogenic Inductors May Become Power Source

By A. HEMEL
Illinois Institute of Technology, Chicago, Ill.

LARGE AMOUNTS of energy that can be stored in cryogenically cooled inductors could become a valuable new source of energy. If practical methods are developed to recover this energy, such inductors might perform some of the functions of rechargeable batteries. For example, supercooled coils might be used as a power source for fleets of automobiles or trucks.

The potential usefulness of cryogenic inductive energy storage was suggested by a report on the behavior of niobium-tin alloy (ELECTRONICS, p 9, Feb. 10). In the superconducting state, average current densities of 100 amp per sq cm were observed in Nb_3Sn, and superconductivity persisted in magnetic fields of 88 kilogauss. Other materials have been produced in which considerably higher currents have persisted in stronger magnetic fields.

Using Stored Energy

The possibilities inherent in this type of energy storage can be demonstrated using a fleet of electrically powered vehicles as an example, although many engineering problems would have to be solved for practical realization.

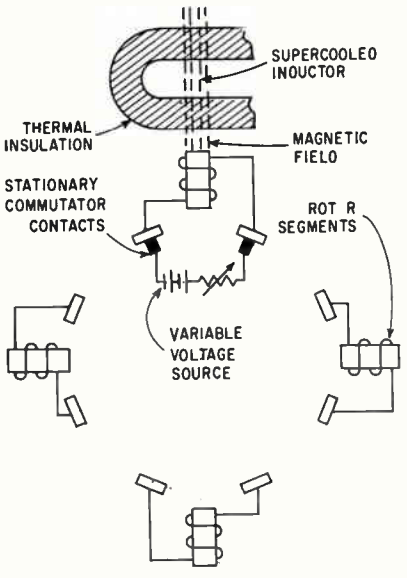
With d-c flowing in a superconducting coil with its ends shorted together, the amount of energy in the coil is $W = 1/2Li^2$, where W is energy in joules or watt-seconds, L is inductance in henries and i is current in amperes. Normally this energy would be rapidly dissipated in i^2r losses but resistance is negligible in a superconductor.

If current in a superconducting wire were 100,000 amperes and the wire were formed into a 1 henry coil, theoretically the inductor could store 1390 kilowatt-hours or 1860 horsepower-hours of energy. If this stored energy could be used in a 200-horsepower electrically powered vehicle, the vehicle could operate at top speed for about 7 hours, assuming 75 percent efficiency in converting electrical energy into mechanical energy.

This energy might conceivably be extracted from the coil using an arrangement like that shown in the figure. One segment of the thermally insulated supercooled coil is extended through a rotating magnetic field forming a d-c motor. Only the supercooled coil segment would be maintained at superconducting temperature.

Current for the rotor segments is assumed to be provided by an auxiliary power source although other arrangements might be possible that would eliminate need for the power supply. The rotating magnetic field would be provided by a commutator.

Force applied to the rotor is $F = Bli$, where B is rotor magnetic field density, l is length of superconducting segment in the rotor magnetic field and i is current through the supercooled stator segment. Because rotor magnetic field density is determined by an electrical power source, power provided to the vehicle by the motor can be controlled electrically.



Rotor segments are the only moving parts of machine that might extract stored energy from supercooled inductor

Counter emf reduces current in the supercooled coil as energy is extracted in accordance with the relationship $E = -Blv$, where E is counter emf and v is velocity of the rotor field passing the stator field provided by the supercooled coil segment. Current is reduced at the rate of $di/dt = -Fv/Li$.

Recharging Cryogenic Inductor

The supercooled coil segment might also be used to recharge the coil. If the rotor were driven in the opposite direction, voltage induced in the supercooled coil would be $E = L\ di/dt$ and the change in current would be $di/dt = -Blv/L$. Because v is negative when the coil is driven in the opposite direction, the value of di/dt is positive. A prime mover at a base of operations for the vehicle could be used to recharge the supercooled inductors by driving them in the reverse direction. Recharged inductors might be kept on hand to keep the vehicles operating while the original inductors are recharged.

Application of cryogenic inductive energy storage requires an adequate supply of liquid helium. Even with the best thermal insulation, heat would leak into the coil, vaporizing the helium. A supply of liquid helium at an operating base seems more practical than providing vehicles with small liquefiers because of their cost.

The estimated cost of providing liquid helium for the vehicles is subject to wide variations and must therefore be made with reservations. One manufacturer offers an 8 liter-per-hour cryostat for slightly more than $30,000. This unit operating continuously could service a maximum of 786 coils having an evaporation rate of ¼ liter an hour. This limited evaporation rate might be sustained by insulating the coils and liquid helium with modified dewer flasks.

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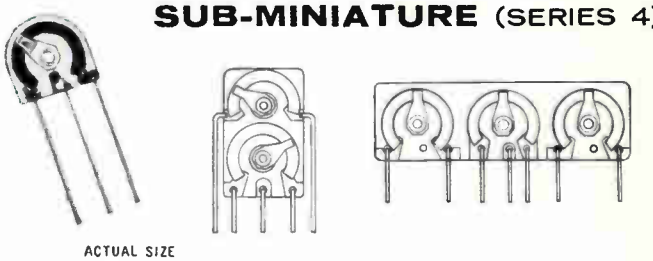
ACTUAL SIZE

Single trimmer measures only 0.250" square, 0.100" deep, rated at .05 watts at 70° C. Multiple trimmers can include up to 5 fixed resistors, depending upon value and voltage rating.

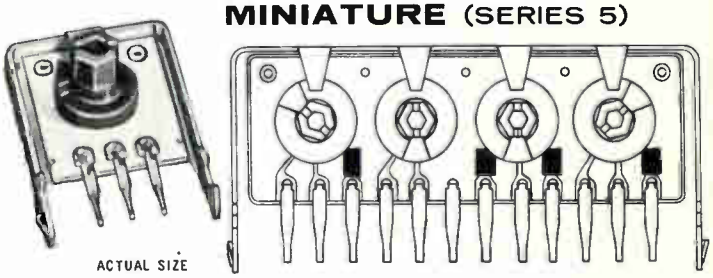
SUB-MINIATURE (SERIES 4)



ACTUAL SIZE

Single trimmer measures only 0.406" x 0.438" x 0.125", rated at 0.1 watts at 70° C. Triple trimmers can include up to 8 fixed resistors, depending on value and voltage rating.

MINIATURE (SERIES 5)



ACTUAL SIZE

Single trimmer measures $\frac{51}{64}$" x $\frac{45}{64}$" x $\frac{19}{32}$". Rated at $\frac{1}{4}$ watt at 70° C. Available with leads, solder or wire-wrap terminals, in a wide range of mounting styles for modern production techniques. One to four variable resistor elements and up to 12 fixed resistors on a single plate. Knob permits adjustment by finger tip, internal or external hex wrench, or screwdriver.

For additional information on these units write for CENTRALAB *Engineering Bulletin 42-1216.*

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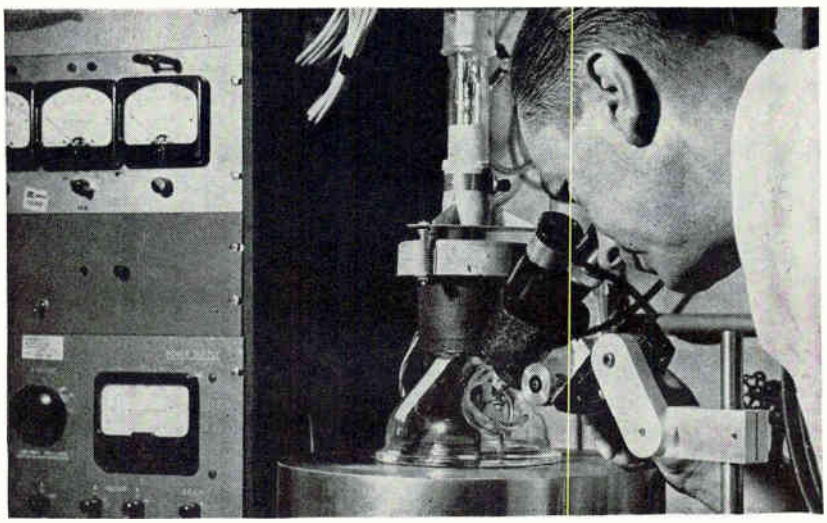
away from the operating base would vary greatly with design of the supercooled inductor, but presently available liquid helium containers require liquification after 3 to 5 days. Total evaporation of the helium must be prevented to prevent coil temperature from rising above the superconducting level, which would cause rapid dissipation of the stored energy in resistive losses. In addition to the inconvenience of losing vehicle power, complete vaporization of the helium could be dangerous. Warning devices would be required to indicate liquid helium level and ensure that heat would be dissipated over a safe period of time.

Extensive research and experimentation will be required to determine whether practical methods can be developed for recovering energy stored in supercooled inductors. If this effort is successful, cryogenic inductive energy storage could provide power for many other applications.

Fabricating Diodes With Electron Beams



Electron beam vacuum processing unit is used in investigating metallurgical and electronic properties of semiconductor junctions

ELECTRON beam processing may be useful in fabricating semiconductor devices. The beams have been used to form aluminum-silicon junctions with good electrical characteristics, and the process seems suitable for automatic production of small and intricate structures.

The fabricating technique has been developed at CBS Laboratories, a division of Columbia Broadcasting System, Inc. A yearlong project was recently completed under sponsorship of the U. S. Army Signal Research and Development Laboratories and has been renewed for another year.

A microjunction diode was fabricated, demonstrating that aluminum-silicon junctions can be formed with good electrical characteristics. The technique indicates the possibility of automatic operation. The electron beam could be directed by a master video control unit as it machines and alloys the semiconductor wafer.

During the past year, two basic patents were obtained on formation of junctions in semiconductors. The electron beam processing unit shown in the photograph was developed. It was used to investigate the metallurgical and electronic properties of junctions and contacts formed by electron bombardment.

It as found that many materials, such as tin, aluminum, silver and gold, could be alloyed onto silicon surfaces by an electron beam. Thin metal films are deposited under vacuum in thicknesses from 2,000 Angstroms to 2 microns.

Under the new contract the physical and electrical effects of electron and ion bombardment are being studied. A structure such as a planar transistor will soon be built.

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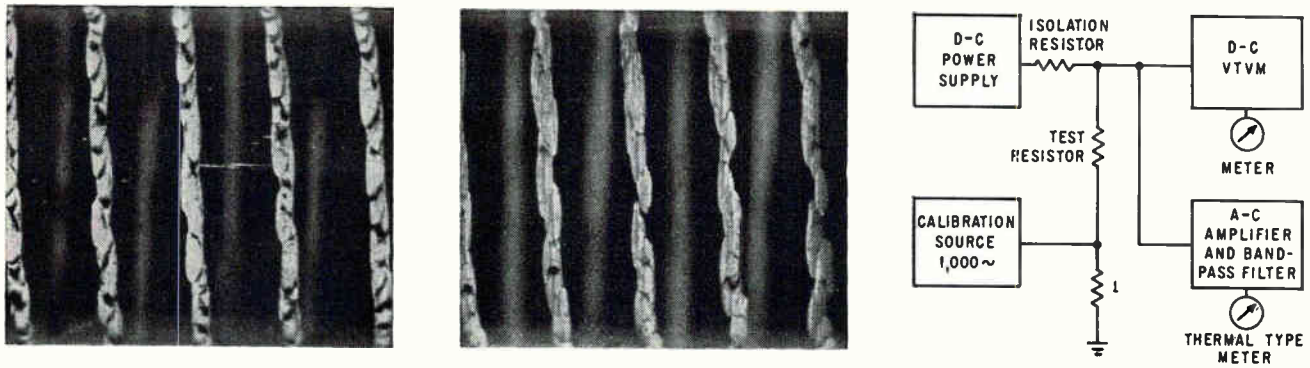


FIG. 1—Noise index of 1.5 db for tin oxide film resistor with scratches (left) was corrected to —18 db by silvering. Noise index of —6.5 db for resistor with bridge defect (center) was corrected to —26.2 db by removing bridge. Final noise performance correlations were made using standard resistor-noise test set (right)

Noise-Performance in Tin Oxide Resistors

By J. G. CURTIS,
Corning Electronic Components,
Corning Glass Works, Bradford, Pa.

DIFFERENT CURRENT noise levels in apparently identical resistors indicate that noise may be related to electrical performance. This hypothesis arises because it is logical to assume that differences in noise level result from differences in construction. However, even though construction differences can be detected visually or electrically, past searches for noise-performance correlations have resulted in limited and sometimes negative findings.

During an investigation of resistor noise at Corning Glass Works, positive noise-performance relationships were observed in tin oxide film resistors. Experiments show that, although not all noisy resistors are substandard, all substandard resistors are noisy. And none of the quiet resistors are substandard.

The data obtained does not necessarily prove that all resistors, or even all tin oxide resistors, exhibit noise-performance relationships. But test results do point up definite relationships that are being extended to confirm the test's usefulness.

As a result of the tests conducted so far, current noise screening is now included on many Corning resistor reliability programs.

Correlating excess noise with construction defects constituted the first phase of the study. A commercial test set was not readily available and a simple wide-band test set was built, which identified unusually noisy samples. This set consisted of a quiet current source (battery), a high-gain audio amplifier, a vtvm for measuring audio output level, and a speaker.

The task of physically examining Corning tin oxide film resistors was no problem, since the glass substrate and the resistive film are relatively transparent. Also, since the film is inherently quiet, small noise sources were easily detected.

Using the test set, in combination with a binocular microscope and a grounding probe, the noise-producing defect was located with precision. The sample (uncoated) resistor was mounted in the test clips and rated voltage applied, with the amplified noise voltage from the resistor fed to the speaker.

The grounding probe connection against the resistive film is itself a relatively noisy contact. This effectively limits the sensitivity of the test method to defects indicated by a noise index in excess of (more positive than) —15 db. A portion of the defects producing noise less than —15 db can be identified as less severe forms of easily recognized defects. The remainder requires a more sensitive system of analysis.

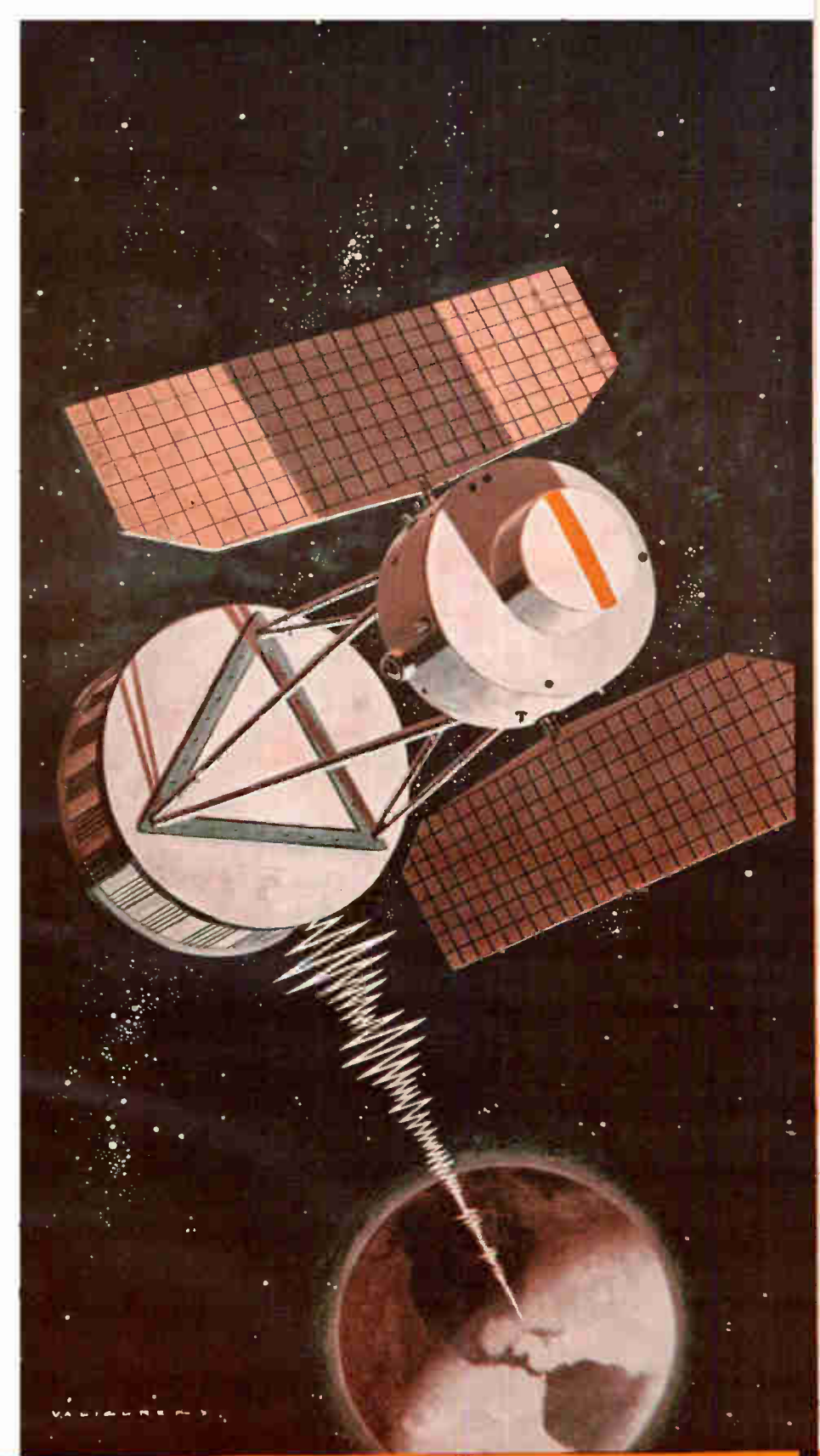
The test isolated some ten modes of noise defects. The samples were not intended to depict conditions existing in finished components. All finished resistors are subjected to power overloads and resistance measurement on the production finishing lines on a 100 per cent basis. The overload level removed units such as those discussed below.

Noise defects were placed in two broad groups. One group consisted of series type defects such as film scratches, film porosity, checks in the substrate glass, wide chips, excessive cap-to-film contact resistance, and ragged path edges. In the other group were parallel defects, including bridges of undisturbed film across the cut path and foreign materials bridging the cut.

Defect locations were confirmed by silvering over series defects and by removing the bridging defects. In some cases, the relatively high 'after' level indicates presence of other defects in the sample. The resistance values of most of these samples were within tolerance.

Once noise-defect correlations were established, load life performance seemed a likely place to look for noise-performance relationships, since drift of resistance is primarily a function of active film area and power loading—other things being equal.

Measurements for noise-perform-



Avco and . . .
satellite signal selection

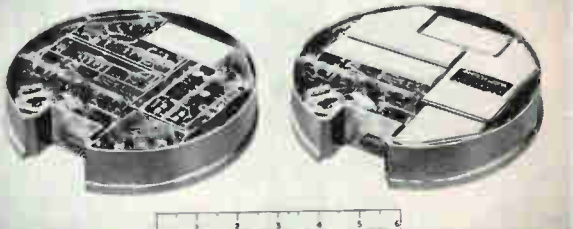
Space vehicles are constantly exposed to many signals as they orbit the earth. Electronic interference, false messages . . . these are but two of the problems they contend with.

To receive correct commands, a new coder-decoder has been developed by Avco's Electronics and Ordnance Division working with NASA. Built around a single-conversion concept, the Avco unit ignores stray signals, shuns radio noise and interference. Today it is operating in Explorer XI, now orbiting the earth.

Miniaturized to save weight and space, this uniquely selective radio device will pull in only proper information, feed it to the decoder, and actuate the correct on-off controls and other satellite equipment as ordered.

Communications capabilities are among the many contributions of the Electronics and Ordnance Division's experienced engineering talent and skill. For more information on this new satellite receiver-decoder, or answers to your own communications problems, write: Director of Marketing, Communications Operation, Electronics and Ordnance Division, Avco Corporation, Cincinnati 15, Ohio.

New Avco receiver-decoder withstands extreme vibration, shock. 6.3" in diameter, only 3.5 lbs.



Avco ELECTRONICS AND ORDNANCE DIVISION

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ance correlations were made on the Quan-Tech Model 315 Resistor-Noise Test Set. This instrument consists basically of a quiet, variable d-c power supply, an accurate vtvm indicating the applied voltage in db, a low-noise, sensitive amplifier with an accurately controlled pass band centered at 1,000 cps, an rms noise voltage meter calibrated in db, and a 1,000 cps calibration source.

Measure of Current Noise

The current noise index was obtained from the relation: Index = T − f (T − S) − D, where T is the measured value of total noise; S is the measured value of system noise before application of test voltage; D is 20 log applied voltage and values of f (T − S) are given in a table in the set's instruction manual as a function of T − S.

The Index is defined as,

$$20 \log \frac{\text{rms noise voltage } (\mu v)}{\text{applied voltage (v)}} \text{ db in a}$$

frequency decade.

To establish load life performance and current noise relationships, an experiment was designed utilizing 4,000 Corning C-20 (½w), 150 K, general purpose tin oxide resistors, chosen from a group where a high defect ratio was suspected. The samples were measured individually and sorted into 12 bins representing 5-db noise modules ranging from 25 to −35 db. A sampling of 100 units were then remeasured for exact noise levels and tagged, after which temperature coefficient (tc) tests were run. Noise levels were remeasured and the samples placed on a 1,000-hour cycled load life test. At the conclusion of the life tests, the units were measured for resistance drift, and for noise.

Analysis of results in both the life test and the tc test showed a striking relationship between noise and performance.

An arbitrary noise index (−21.3 db) could be assumed below which there were no instances of abnormal tc and no instances of abnormal drift.

The dividing line between normality and abnormality was established as follows. Temperature co-

efficient was measured at −15 deg C, −55 C, 65 C and 150 C, referred to 25 C. Values for the type of film used on this unit generally exhibit a nominal tc lying close to 0 ppm/deg C, with maximum excursions in the area of 100 to 150 ppm/deg C. Values exceeding 150 ppm for this particular resistor were consequently termed abnormal. In the group quieter than the arbitrary noise level, the largest tc found was −93 ppm/deg C, at 150 C. In the noisy group, certain tc's were observed ranging from 335 to −3,284 ppm/deg C with values scattering wildly, even though the majority of pieces behaved normally.

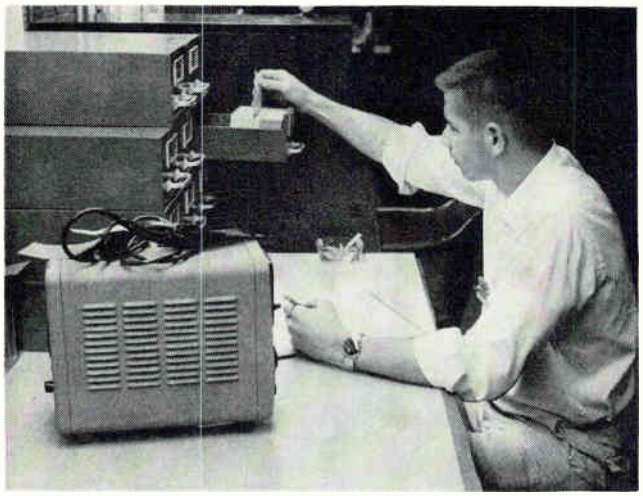
Quiet and Noisy Samples

In the load life performance, this particular resistor was considered abnormal if it drifted appreciably with a negative slope at any time during the 1,000 hour period, or if it drifted with a positive slope at a rate not commensurate with the other members of its group. In the quiet samples, there were no appreciably negative drifts. Maximum and minimum drifts were 0.59 per cent and 0.21 per cent respectively. In the noisy group, there were many instances of negative drift. Maximum values of drift ranged from 2.07 per cent to −2.11 per cent. It is interesting to note that even the maverick drifters in the group did not exceed the 3 per cent allowable for this style resistor.

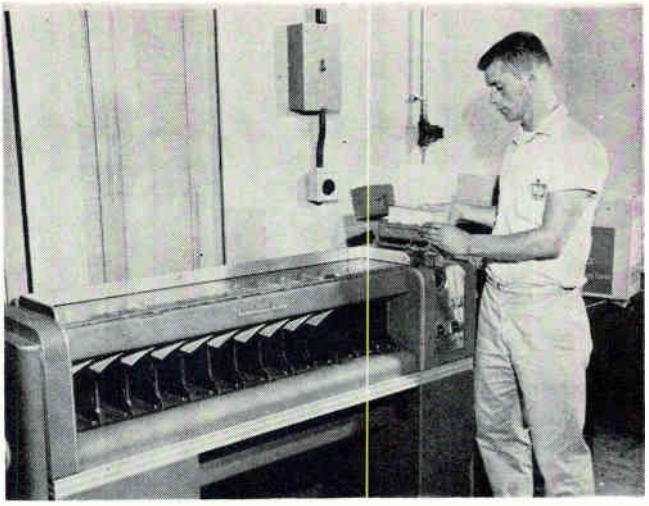
An analysis of this data indicates that for this particular sample, all resistors destined for erratic tc and life performance could have been eliminated by removing units exceeding a noise index of −21.3 db. Since tested pieces constituted a sample of a much larger group, a similar sorting at the same noise level would eliminate potential failures with high efficiency.

The majority of rejected pieces would not necessarily exhibit substandard performance in standard tests, even assuming they are, to some degree, abnormal in construction.

Corning is continuing the experimentation for tin oxide films, and will publish findings when they are available.



Each instrument has an identification number, is scheduled for a current job and as many as two future jobs



Special information about instruments, such as the number required by a given contract, is quickly available

Controlling Production Test Instruments

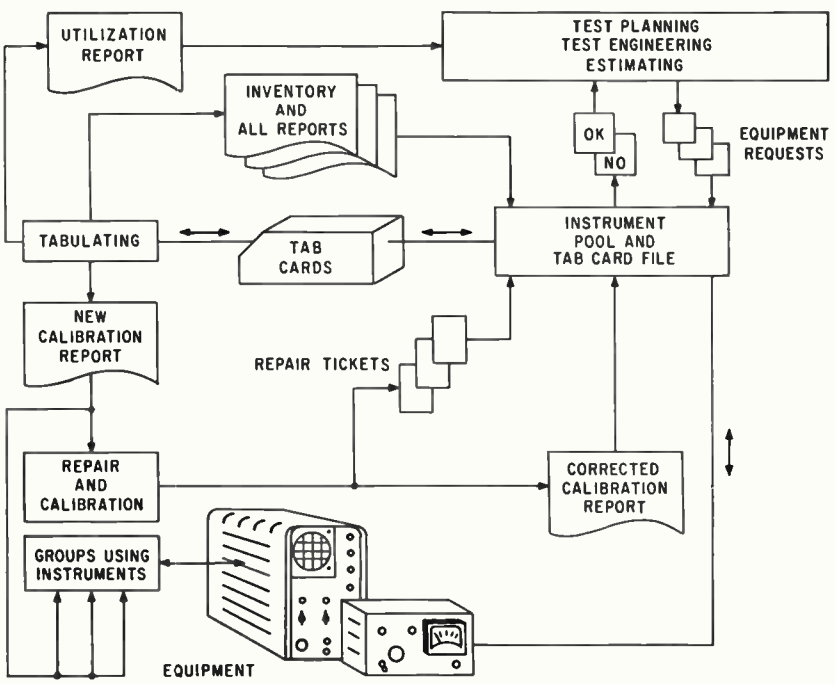
By C. M. WEEMS, JR.,
Electronics Div.,
Westinghouse Electric Corp.,
Baltimore, Md.

DURING THE PAST DECADE several problems have developed in the efficient use of test equipment in production. There has been a general and rapid increase in measurement precision and a significant increase in the variety and complexity of equipment. Calibration has become more rigorous and difficult, and obsolescence of general equipment is rapid. There is also increased need for special expensive equipment that is required only for relatively brief intervals during a particular contract.

These problems are compounded by the industry-wide trend away from a few high-production-rate contracts to many low-quantity, high-complexity contracts. At Westinghouse in Baltimore, Md., greater efficiency in instrument use has been obtained with standard punched-card, data-processing equipment normally available in accounting departments.

The system is designed to perform three separate functions from one control center: planning and controlling the utilization of equipment; providing records and controls for regular calibration of all equipment; and collecting repair records for cost control. Two tab cards for each instrument provide space for all the necessary data and some extra room for possible future needs. One card, the calibration card, contains identification data and all data required for calibration and repair. The second card contains equipment utilization information and enough basic identification for the cards to be used and processed essentially as one. Basic identification consists of the name of the equipment, identification number, manufacturer, model number, serial number and, if borrowed, the owner's identification number. This information is entered only for a new instrument and, in general, never changes. The local identification number is stamped in a metal tag affixed to the instrument when it is procured; it remains a permanent part of the instrument.

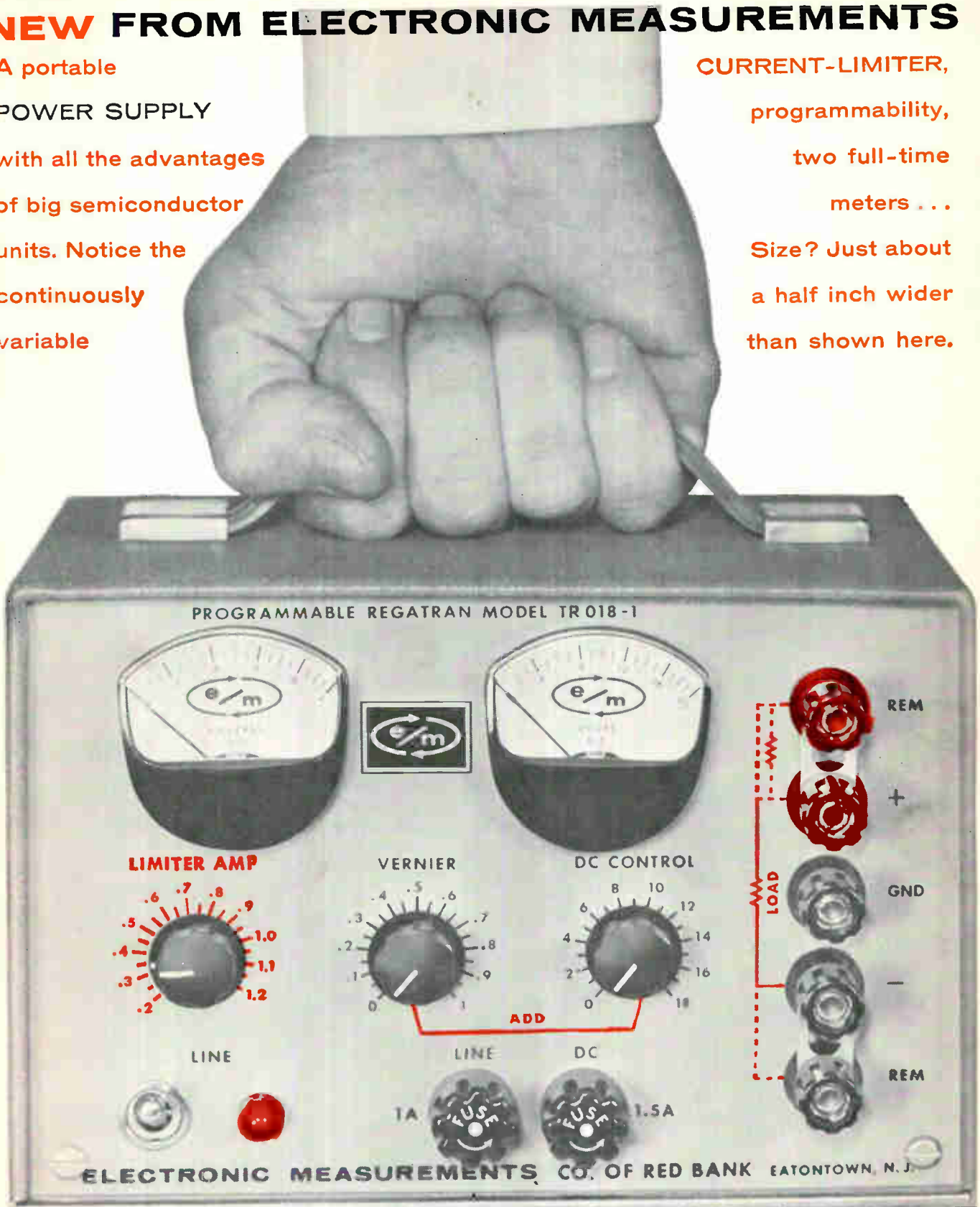
Outputs from the tabulating ma-



Three reports—utilization, calibration, inventory—are the major tools controlling test instrument flow

NEW FROM ELECTRONIC MEASUREMENTS

A portable POWER SUPPLY with all the advantages of big semiconductor units. Notice the continuously variable CURRENT-LIMITER, programmability, two full-time meters . . . Size? Just about a half inch wider than shown here.



ELECTRONIC MEASUREMENTS

COMPANY OF RED BANK

EATONTOWN · NEW JERSEY

CIRCLE 105 ON READER SERVICE CARD 105

Data on instrument use is up to date, allowing rush jobs to be handled efficiently

chines are three reports interpreting the punched data found along the top of the cards. The three reports—utilization, calibration, inventory—are normally prepared once a month. The utilization report contains the basic identification of the instrument and the dates for its present job and for two future scheduled jobs. Test planning uses this report to schedule future contracts and to determine what new equipment is required. This report is listed by the equipment's name, manufacturer and model number.

The inventory report is the master report used by the instrument pool to locate equipment and cross index other information. This report is listed by identification number and contains all the basic identification, utilization, and repair data.

The calibration report is listed by the group using the equipment, and within that by the calibration due date, and then by identification number. Both the calibration group and the equipment user get a copy of this report. The basic flow is illustrated in the figure.

Instrument Pool Has Control

The instrument pool is the central control for movement of equipment and record keeping. In the case of test equipment utilization, this represents more clerical control than actual control, with actual control resting in test planning. The test planner uses the utilization report to select the instruments needed for a particular contract. The instrument pool puts this information on the tab cards, and

a comprehensive guide to current information on every branch of Science and Technology

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New from McGRAW HILL

If you find yourself among the growing number of science and engineering specialists unable to keep up with the explosive pace of developments today, you will see a valuable solution at the top of this page.

thus the instruments are reserved. A check form used by the test planner prevents two planners from reserving the same instrument during the month before the next utilization report is available.

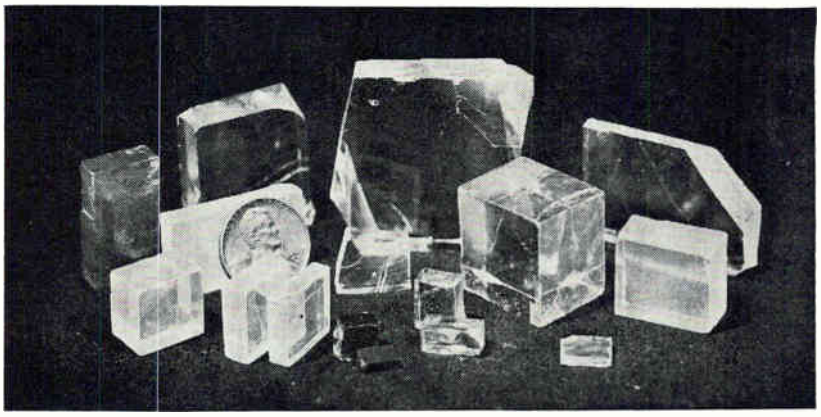
The calibration report is issued to the group using the equipment so they have a current inventory of what instruments they are charged with and when an instrument is scheduled for calibration. The calibrator feeds corrections back into the system by marking his copy of the calibration report; the instrument pool corrects the tab cards. Since all calibrations are scheduled during the first 15 days of the month, ample time is allowed for card correction.

Repair data consists of the number of times an instrument is repaired, total repair man-hours and replacement parts cost. This data, entered by the repairman and then added to the tab card by the instrument pool, is used to aid in determining the total cost of repair, when to retire an instrument, to rate manufactures and to spot unreliable instruments.

Automatic Pliers For Volume Operation

Automatic cut-off pliers, a boon to any operation that uses pliers for volume operation, have been developed by the tool design department at the IBM Poughkeepsie plant. Air-operated and controlled either by a foot switch or hand pistol grip, the pliers cut wire, crimp it, or form it in any specified length, depending on the type of plier head used. The device (not a commercial product) eliminates the hand fatigue in operations that require long or excessive use of manual pliers

New On The Market

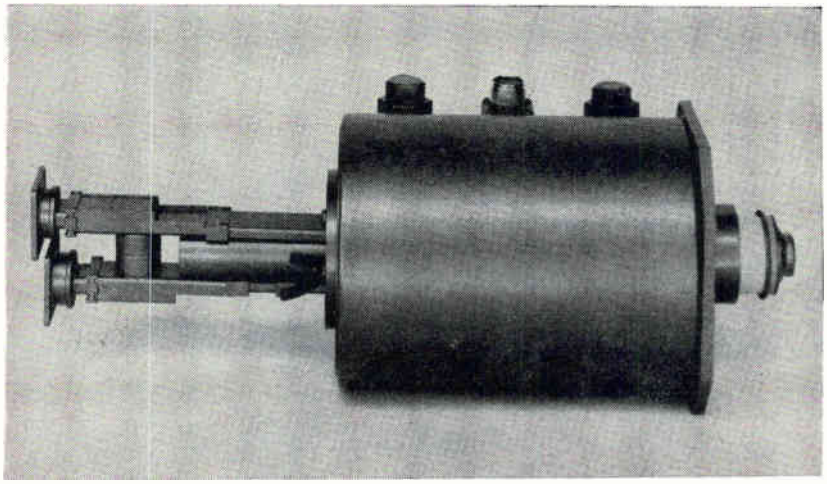


High Purity Magnesia Crystals

WITH DIMENSIONS UP TO ¾ IN.

NORTON CO., Worcester 6, Mass., is producing single crystals of Magnorite fused magnesia in developmental quantities with dimensions up to ¾ in. Company techniques have made it possible to produce crystals of predetermined quality. The process also permits making crystals with definite percentages of known impurities. The doped crystals exhibit different electronic characteristics when the impurities consist of certain metallic transition elements. Major fields of application of these crystals is in laser and maser studies.

CIRCLE 301 ON READER SERVICE CARD



High Power C-W T-W Tube

METAL-CERAMIC CONSTRUCTION

HUGHES AIRCRAFT CO., 11105 S. La-Cienega Blvd., Los Angeles 9, Calif. The 355H is a broadband c-w twt producing 1 Kw minimum power output at X-band. It can be operated from 8.0 to 11.0 Gc without electrical or mechanical adjustment. It weighs 30 lb complete with solenoid, and is suited for frequency diversity c-w radar, high power countermeasures jammers and extremely wideband communications system applications.

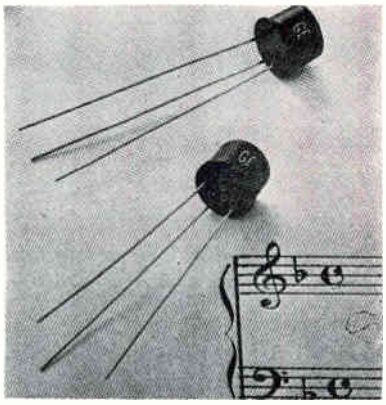
CIRCLE 302 ON READER SERVICE CARD

Compression Amplifier

WITH AGC

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. Model OR-LA/1 linear amplifier with automatic stepped gain control has a wideband response of from 30 to 20,000 cps and low distortion. Input signals of up to 100 db dynamic range can be compressed to 20 db. Variable gain is provided in discrete 10 db increments. Output gain is continuously adjustable from 0 to 50 db, for a maximum output voltage range of 1 to 10 v.

CIRCLE 303 ON READER SERVICE CARD

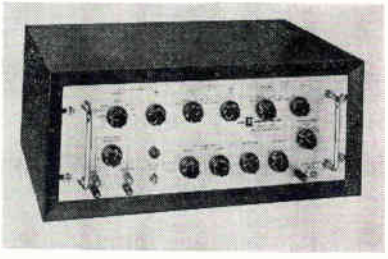


Low Current SCR

ALL DIFFUSED

GENERAL ELECTRIC CO., West Genesee St., Auburn, N. Y. The C5 silicon controlled rectifier will be used as both a sensitive signal amplifier and power switching element in the low power switching control circuits. It may also be operated as a h-v *pnp* transistor. Eight models differ by forward breakover voltages which range from 25 v to 400 v. The devices will accommodate transient peak reverse voltages up to 500 v. Average forward current rating is 1 ampere d-c at 82 C case temperature.

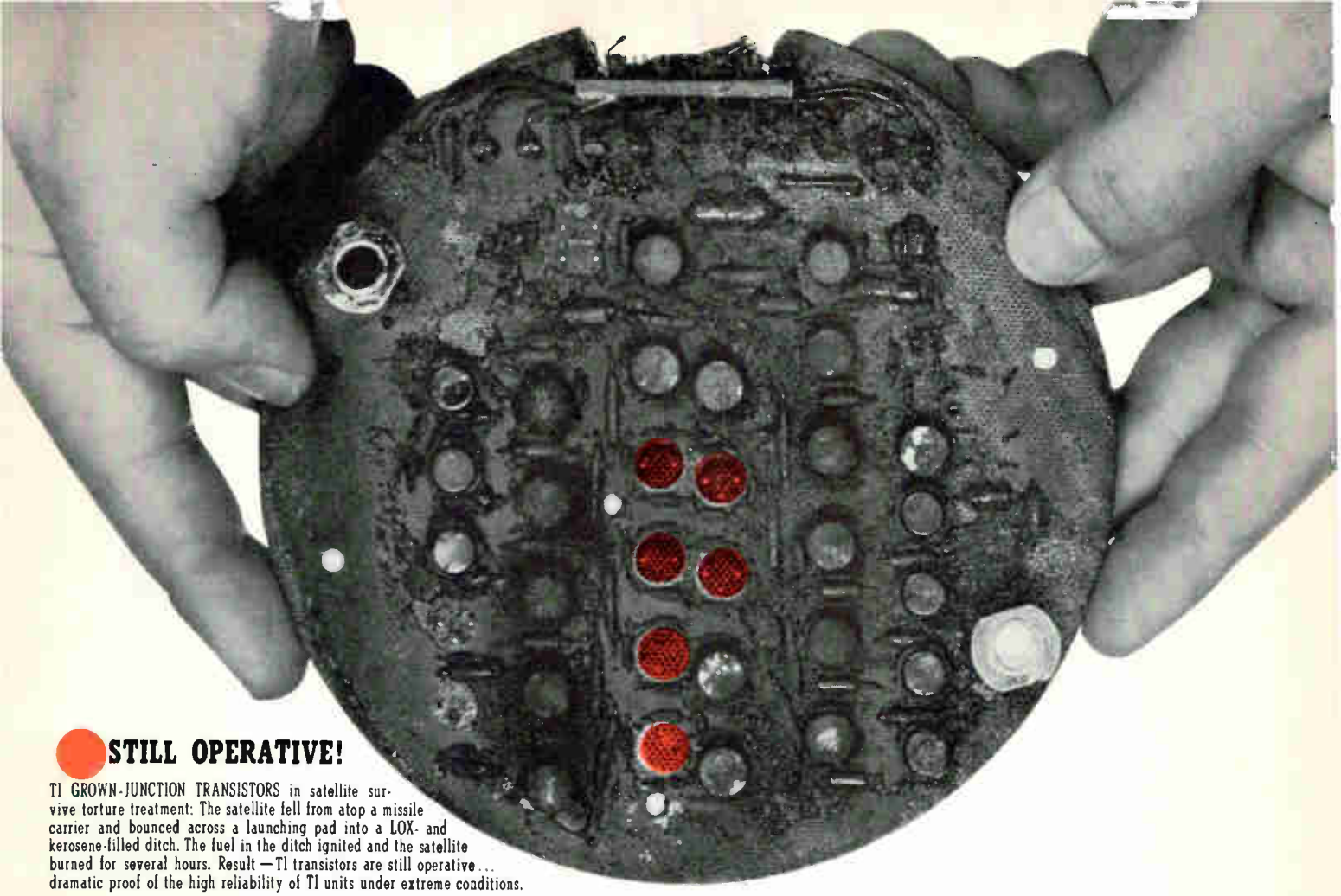
CIRCLE 304 ON READER SERVICE CARD



Pulse Generator

VARIABLE RISE TIME

RESE ENGINEERING INC., A & Courtland Streets, Philadelphia 20, Pa. Model 203 has an output pulse whose rise and fall time can be varied continuously from 20 nsec to



STILL OPERATIVE!

TI GROWN-JUNCTION TRANSISTORS in satellite survive torture treatment: The satellite fell from atop a missile carrier and bounced across a launching pad into a LOX- and kerosene-filled ditch. The fuel in the ditch ignited and the satellite burned for several hours. Result—TI transistors are still operative... dramatic proof of the high reliability of TI units under extreme conditions.

Here's Long-term Proof of TI Grown-Junction Transistor Reliability

Only Texas Instruments offers life-test data from lots that have been continuously on operating life test for over five years — showing an extremely low average failure rate of less than 5×10^{-6}. More than *six-million life-test hours* give you the industry's greatest source of reliability data for predicting TI transistor performance.

Successful applications in thousands of circuits over the years testify to the *consistent* reliability of these TI units.

Independent Quality and Reliability Assurance department augments TI's own production and testing know-how... *independently* measuring device reliability at every manufacturing stage. Approximately one-million life-test hours *monthly* offer continuous verification of TI grown-junction reliability.

Low cost of TI grown-junction transistors is made possible through industry's wide acceptance and usage of these units in many applications, enabling TI to provide fast, cost-saving production in large quantities. Added savings in time and money too, through *one-source purchasing* from TI's complete line of military and industrial grown-junction types.

Take advantage of the predictable reliability of these devices in your low frequency and switching designs. Call your local TI sales office or TI distributor now for immediate delivery in sample or production quantities.

Write on your company letterhead for TI grown-junction reliability data, application notes, data sheets or engineering assistance.

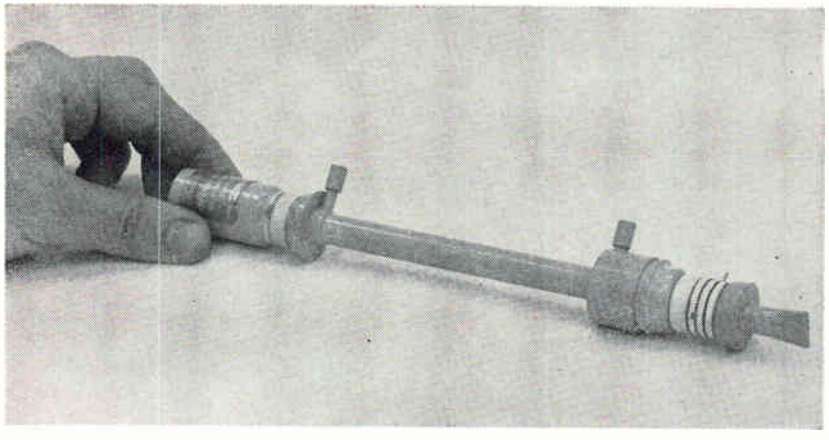
TRANSISTOR PRODUCTS DIVISION

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

18594

2 μsec. Unit has a prf of 30 cps to 3 Mc and will trigger on any kind of a positive or negative input waveform of 6 v minimum amplitude at frequencies as low as 30 cps. Both delay time and output pulse width can be varied continuously in 4 decade ranges from 50 nsec to 1 millisec. Jitter is less than 0.1 percent over-all.

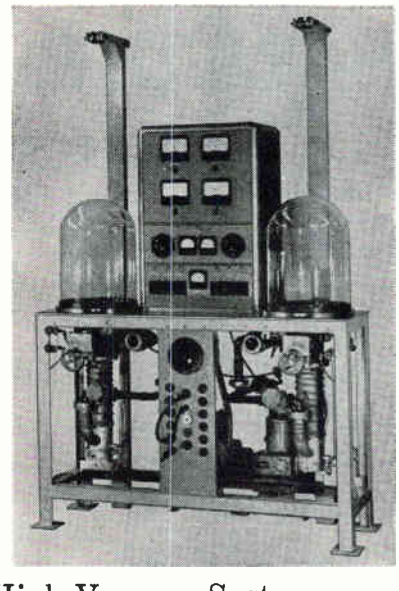
CIRCLE 305 ON READER SERVICE CARD



Miniature Traveling Wave Tube
FOR SPACE COMMUNICATION

SPERRY ELECTRONIC TUBE DIV., Sperry Rand Corp., Gainesville, Fla. The STX-186 miniature twt hikes power and bandwidth for space communication systems. It can produce more than 10 w over frequency ranges from 5,000 to 11,000 Mc. The twt weighs only 1 lb and is 9 in. long. This miniaturization was achieved while realizing a 4.0 db gain within the tube. Current units are priced at approximately $3,500.

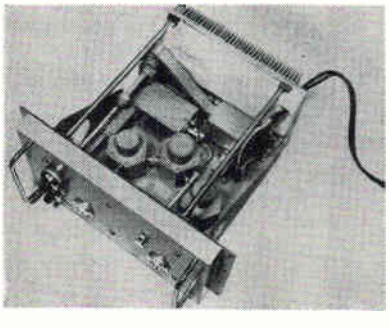
CIRCLE 306 ON READER SERVICE CARD



High Vacuum System
DUAL UNITS

VACUUM EQUIPMENT AND COMPONENTS, Division of Suburban Plastics Co. Inc., 4041 Ridge Ave., Philadelphia 29, Pa., has developed the Dual 12 vacuum system, designed to produce a vacuum of 1 by 10^{-4} mm Hg in less than 10 minutes and 5 by 10^{-5} mm Hg in less than 20 minutes. It was developed for depositing thin films on electronic components. System consists of two independently operating units mounted on a common frame.

CIRCLE 307 ON READER SERVICE CARD



Parametric Amplifier
2 DB NOISE FIGURE

MICROMEGA CORP., 4134 Del Rey Ave., Venice, Calif. A uhf parametric amplifier designed to reduce the noise figure of existing receivers is tunable in minutes from 750 Mc to 1,000 Mc. It can be supplied with mixer and local oscillator to provide output at an intermediate frequency. The one-port, reflection-type amplifier utilizes mechanically tunable ferrite circulators. Gain is 17 db; bandwidth, 10 Mc; input and output impedance, 50 ohms.

CIRCLE 308 ON READER SERVICE CARD

Sphygmomanometer
AUTOMATIC UNIT

SYSTEMS RESEARCH LABORATORIES, INC., 500 Woods Drive, Dayton 32, O. Portable automatic blood pressure measuring instrument performs in about 18 sec the same duties as the physician's stethoscope, manometer and ears. It utilizes transistor logic for performing the automatic program functions. To perform switching operations, it employs solid state devices. Three techniques are employed to minimize noise interference: a contact type microphone, a coincidence circuit and the logic design of the programmer.

CIRCLE 309 ON READER SERVICE CARD

Fluid Quality Meter
FOR CRYOGENIC WORK

ALLIED RESEARCH ASSOCIATES, INC., 43 Leon St., Boston 15, Mass., has developed an automatic instrument that continuously measures the fluid quality in a two-phase cryogenic flow system. Its operation is based upon the determination of dielectric constants of the liquid and of the vapor in two-phase fluids such as liquid hydrogen, liquid oxygen and liquid nitrogen. Instrument pro-

Now Mincom offers the industry extended bandwidth and improved predetection recording...the MINCOM Series CM-100 Instrumentation Recorder/Reproducer

At 120 ips the Mincom Series CM-100 now delivers 1.5 mc* —and also makes possible predetection recording/reproducing with dropouts virtually reduced to zero. This superb improvement in predetection performance is accomplished by redundant data recording. The two carrier tracks are fed through a new and exclusive Tracklok® to eliminate skew, and thence as a single track into a demodulator to recover the original information. It's well worth seeing, especially if you need reliable operational predetection at your facility—and need it in FM/FM modulation, PCM and PCM/FM.

*Optional

1.5 megacycles* ...at 120 ips

MINCOM SERIES CM-100

Frequency response of 1.5 mc is obtained in the single-rack CM-100. A second auxiliary rack houses a demodulator, an oscilloscope monitor unit, and Mincom's new and exclusive Tracklok.

Mincom Division 3M MINNESOTA MINING & MANUFACTURING CO.

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vides a continuous indication of percent vapor, by volume, over the range 0 to 100 percent vapor with an accuracy of 1 percent full scale, and to within 1 db to 400 cps.

CIRCLE 310 ON READER SERVICE CARD

F-M Deviation Meter
LOW DISTORTION

DERO RESEARCH & DEVELOPMENT CORP., Broadway & Park Ave., Huntington, N.Y. The DM-4A is designed to measure and analyze f-m signals in the missile range command band of 400-550 Mc. It is a low sensitivity f-m receiver employing a stable counter type discriminator where the demodulated signal is displayed on a direct reading deviation meter. Calibration accuracy is 1 percent. Price is $1,595.

CIRCLE 311 ON READER SERVICE CARD

Microwave Switch
SOLID-STATE

SOMERSET RADIATION LABORATORY, INC., 192 Central Ave., Stirling, N. J. Ultra-high speed double-throw microwave switch features relatively-high power handling capability over the frequency range 8,200-12,400 Mc. Temperature range is — 55 to + 90 C.

CIRCLE 312 ON READER SERVICE CARD

Miniature D-C Pot
HIGH ACCURACY

SENSITIVE RESEARCH INSTRUMENT CORP., 310 Main St., New Rochelle, N. Y. Model PC PocketPot is suited for use as an infinite impedance calibrator or measuring instrument.

Ranges: 0-5.100 v. When used with PC-S curent-volt-box, 0-500 v and 0-1 amp. Resolution: continuous, 1 mv divisions on slide wire. Accuracy: ± 0.05 percent of reading or ± 0.5 mv, whichever is greater.

CIRCLE 313 ON READER SERVICE CARD

Clutched Synchro
SIZE 10 PACKAGE

ASTRODYNE INC., 121 Clinton Rd., Caldwell, N. J. Size 10 package contains electromagnetic clutch, spring return mechanism and synchro for computer applications. The return mechanism is set to ± 1 minute of electrical zero of the synchro and repeats synchro position to within ± 1 minute. Synchro can be rotated through 360 deg.

CIRCLE 314 ON READER SERVICE CARD

Transformers
WELDABLE LEADS

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N.Y., announces miniature transformers with weldable leads to permit high reliability welded connections in high-density electronic assemblies. Special gold plated nickel iron alloy lead wire is used to provide superior weld joints.

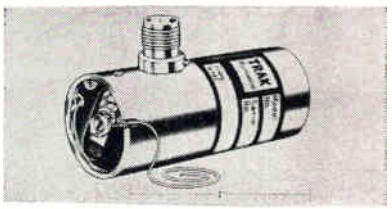
CIRCLE 315 ON READER SERVICE CARD

Broadband Switch

RMS ENGINEERING, INC., P.O. Box 6354, Station H, Atlanta 8, Ga. Model RFS-LU broadband r-f switch covering the frequency range

200 to 400 Mc provides a means for rapidly gating the input of a receiver.

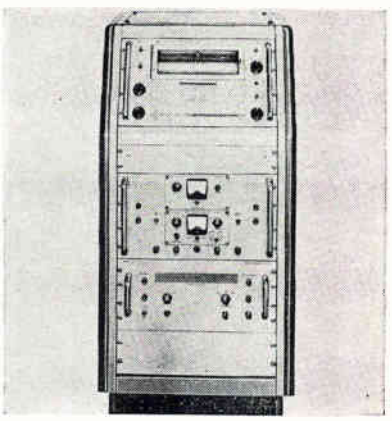
CIRCLE 316 ON READER SERVICE CARD



Microwave Oscillator
MICROMINIATURE

TRAK MICROWAVE CORP., Tampa, Fla. Type 2970 (CW) is $\frac{7}{8}$ in. in diameter and 2 in. long and weighs 3 oz. It will tune the entire C-band from 5.2 Gc to 6.0 Gc by adjusting a screw on one end of the C-band cavity. Power output is greater than 10 mw from 5.4 to 5.9 Gc and greater than 5 mw over the entire band.

CIRCLE 317 ON READER SERVICE CARD



Contour Plotter
THREE-DIMENSIONAL

SCIENTIFIC-ATLANTA, INC., 2162 Piedmont Road, N.E., Atlanta 9, Ga. Model ACP 1 antenna contour plotter maps ϕ, θ, and amplitude coordinates quickly and easily in the new IRIG format. Used with model PCP1 automatic positioner programmer and two-axis positioner, a complete contour plot can be made by raster scanning over the sphere of radiation of an antenna, missile or scale model of an airframe.

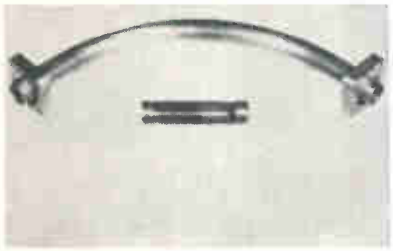
CIRCLE 318 ON READER SERVICE CARD

Ceramic Capacitors

CENTRALAB, division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. These 20-v Ultra-Kap

ceramic capacitors for use in semiconductor circuits are available in values of up to 0.2 μf.

CIRCLE 319 ON READER SERVICE CARD



Waveguide Bends
FOR MILLIMETER BAND

TRG, INC., 9 Union Square, Somerville, Mass., is fabricating simple and complex bends in millimeter-band circular waveguides for operation in the low loss TE_{01} mode. The bends are made by first corrugating the inside of lengths of straight copper waveguide and then bending them to the desired shape. A typical 90 deg bend at 70 Gc has a 3 in. radius, and 0.3 db loss.

CIRCLE 320 ON READER SERVICE CARD

Power Supply
WITH DIAL OPERATION

DAVENPORT MFG. DIV., Duncan Electric Co., Inc., 2530 N. Elston Ave., Chicago 47, Ill. Line of d-c power supplies is available with both constant voltage and constant current output as selected by the operator without need for calibrating or balancing null meters. Six models cover ranges of 100 v and 1,000 v d-c at currents of 100 ma and 1 amp. Units have a repeatable accuracy of 0.01 percent, and an absolute accuracy of 0.05 percent, as referenced to the international volt, as corrected.

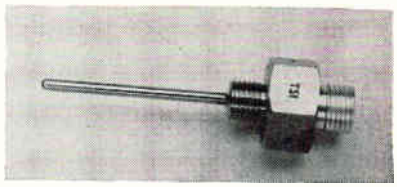
CIRCLE 321 ON READER SERVICE CARD

Oscilloscope

TEKTRONIX, INC., P. O. Box 500, Beaverton, Ore. Type 661 dual-trace oscilloscope is a complete

pulse-sampling system with rise-time of 0.35 nsec.

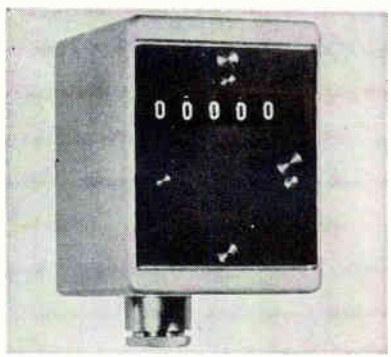
CIRCLE 322 ON READER SERVICE CARD



Temperature Sensor
PLATINUM IMMERSION

TEMPERATURE SYSTEMS, INC., 1871 South Orange Drive, Los Angeles 19, Calif. Platinum immersion temperature sensor has been designed and tested to meet nuclear environments of 1(11) ergs/gram(c) gamma and 1(15) n/cm², En > 2.9 Mev neutron flux. It is rated at 100 ohms at 32 F and covers a temperature measuring span of −364 to + 1,000 F.

CIRCLE 323 ON READER SERVICE CARD



Impulse Counter
SURFACE MOUNTED

LANDIS & GYR, INC., 45 W. 45th St., New York 36, N. Y. Type TCeBZ5A surface mounting, 5-digit Sodeco electric impulse counter has a rectifier incorporated to provide reliable d-c operation direct from a 110 v a-c source. It may be used with any pulse generator capable of creating a pulse of the required specifications. The coil may be continuously energized. Rated counting speed is 667 counts/min.

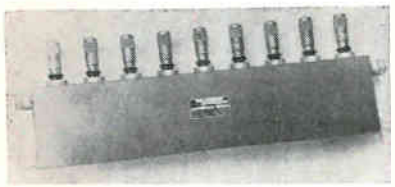
CIRCLE 324 ON READER SERVICE CARD

Oscillograph
RECORDING/PROJECTING

MICROSOUND, INC., 4627 Leahy St., Culver City, Calif. The Datascope/RPO is a two-channel recording/projecting oscillograph that pro-

vides immediate viewing and a permanent record of variable or transient phenomena from d-c to beyond 600 cps.

CIRCLE 325 ON READER SERVICE CARD



Bandpass Filter
MULTIPLE-TUNED

FREQUENCY ENGINEERING LABORATORIES, P.O. Box 504, Asbury Park, N.J. A nine-section bandpass filter features steep skirt selectivity. Tunable over a frequency range of 2,200-2,300 Mc, it has a rejection bandwidth of 40 and 86 Mc at 3 db and 50 db respectively. Insertion loss of the unit is 1.0 db max and input vswr with matched load is 1.3:1.

CIRCLE 326 ON READER SERVICE CARD

Trimmer Capacitor
WITH P-C TERMINAL

ERIE RESISTOR CORP., Erie, Pa. Style 538 miniature ceramic trimmer capacitor measuring ⅜ in. in diameter is available with a printed circuit terminal that is readily inserted in standard p-c mounting holes. When mounted the trimmer is horizontally adjustable, thus eliminating the need for vertical clearance for adjusting or removing the entire assembly in order to adjust.

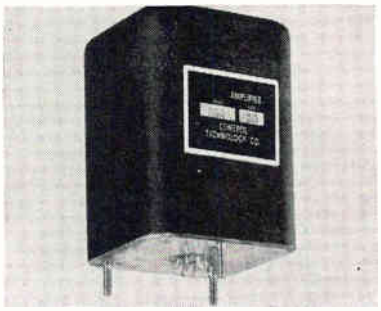
CIRCLE 327 ON READER SERVICE CARD

Circuit Synthesizer

INSTANT CIRCUITS CORP., Terminal Drive, Plainview, L. I., N. Y. Com-

pact circuit synthesizer eliminates the need for soldering and combines ease of operation with modular convenience.

CIRCLE 328 ON READER SERVICE CARD



Isolation Amplifier
TRANSISTORIZED

CONTROL TECHNOLOGY CO., INC., 41-16 29th St., Long Island City 1, N. Y. Model 260 features 20,000 ohm input impedance, a gain of 40, and a gain accuracy of 0.1 percent over the temperature range of — 55 to 125 C. Used to drive resolvers, synchros, potentiometers or other transducers in airborne or ground support applications.

CIRCLE 329 ON READER SERVICE CARD

Infrared Hygrometer
HIGH SENSITIVITY

GENERAL MILLS, INC., 1620 Central Ave., Minneapolis 13, Minn. Infrared hygrometer can measure water vapor in factory, laboratory or the atmosphere. It is proposed for use in meteorology, studies of evaporation, monitoring and control of humidity in environmental chambers and plant processes, and as a laboratory standard for other types of humidity devices.

CIRCLE 330 ON READER SERVICE CARD

Sampling Scope

HEWLETT-PACKARD CO., 1501 Page Mill Road, Palo Alto, Calif. Sampling oscilloscope gives calibrated,

high resolution measurement of nanosecond pulse phenomena.

CIRCLE 331 ON READER SERVICE CARD

NOR-Gate
CONVERTIBLE

DIGITAL DESIGN CORP., Box 21, Clay, N.Y. Model N-131-DC Nand-Gate (NOR-Gate) features two triple input and two dual input gates. Additional inputs are available by terminal interconnection by the user. Switching rates up to 1 Mc are accommodated. Addition of external capacitors converts the device to an integrator, a differentiator or multivibrator. Connector is a 35-pin plug.

CIRCLE 332 ON READER SERVICE CARD

Semiconductor Housing
HIGH-ALUMINA

CERAMASEAL, INC., New Lebanon Center, N.Y. High-alumina semiconductor housing features a ceramic-metal bond that remains high-vacuum-tight during continuous operation at 350 C in air. Bonding technique is a variation of the active alloy process. Advantages of high-alumina ceramic over glass include higher resistance to thermal and mechanical stresses, and longer creepage paths in a compact design.

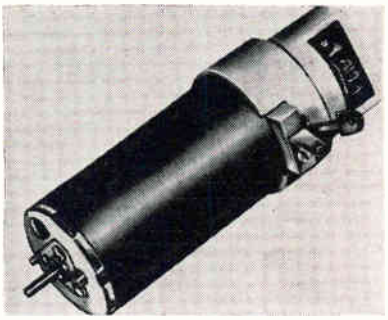
CIRCLE 333 ON READER SERVICE CARD

Epoxy Compounds
7 TRANSPARENT COLORS

TECHFORM LABORATORIES, INC., 332 Sunset Ave., Venice, Calif. Series EPC100 potting and encapsulating compounds combine the advantages

of easily identifiable colors and complete transparency, thus allowing both color coding and viewing of embedded components, regardless of casting size.

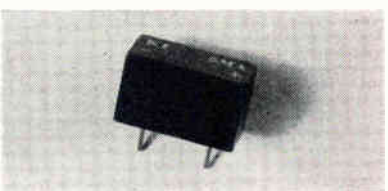
CIRCLE 334 ON READER SERVICE CARD



Small D-C Motor
BATTERY-POWERED

JONARD INT. CORP., 624 Madison Ave., New York 22, N.Y. A 9-v battery-powered motor offers excellent control with less than 2 percent variation in speed and a low power consumption rating. A critical component of the motor is its governor-regulator with a torque measured at a constant 2050 rpm. However, variations of 500 to 600 rpm centered on 2050 rpm can be made with a simple screw adjustment.

CIRCLE 335 ON READER SERVICE CARD



Current Regulator
TWO-TERMINAL

GRAFIX CO., 2841 San Mateo Blvd., N.E., Albuquerque, N.M. The KI 2-terminal constant current regulator is useful in applications where a low dissipation, voltage-dropping component with a constant current or negative resistance characteristic is needed. With a 2,000 cps sinusoidal ripple modulation over the range from 10 to 28 v d-c, current is regulated to within 1 percent.

CIRCLE 336 ON READER SERVICE CARD

Foamed Plastic Pack

PAC-TRON, INC., 225 Crescent St., Waltham, Mass. Custom-designed

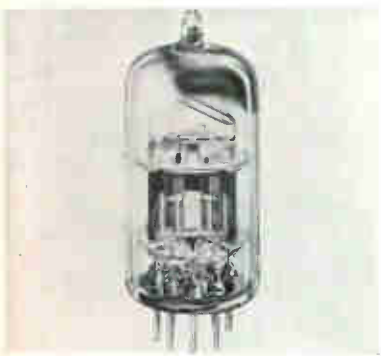
packaging of expanded foamed plastic is used to protect delicate components and assemblies during shipment.

CIRCLE 337 ON READER SERVICE CARD

Thermistor Mounts
BROADBAND

GENERAL MICROWAVE CORP., 47 Gazza Blvd., Farmingdale, N.Y. Model 402 series of temperature-compensated thermistor mounts cover the frequency range from 0.01 to 18.0 Gc. They are designed for measurement of a wide range of c-w or modulated powers in conjunction with model 450 precision microwave power meter which features a direct-reading accuracy of 0.5 percent of full scale.

CIRCLE 338 ON READER SERVICE CARD



Miniature Pentode
TWO FRAME GRIDS

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. Type 7788, a miniature 9-pin pentode incorporates two frame grids (control and screen) to attain a transconductance of 50,000 μmhos at 35 ma. It is designed for use in broadband amplifying circuits such as radio and tv relay systems, coaxial telephone lines, radar equipment and oscilloscopes. It has a figure of merit of 410 Mc.

CIRCLE 339 ON READER SERVICE CARD

Preamplifier

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Mini-

NEW KEITHLEY AC AMPLIFIER

can increase scope sensitivity 1000 times!

The Keithley Model 103 gives you the best attainable signal-to-noise ratio for source impedances from 3000 ohms to over 10 megohms. (The equivalent input noise resistance on the low noise position is only 3 k ohms.) Bandwidth of .1 cps to 100 kc covers a wide range of uses; eleven high and low frequency cuts permit restricted bandwidths for minimum noise.

Applications include Hall Effect studies, bridge null detection, and semi-conductor investigations, as well as such biophysical applications as recording nerve action potentials.

The usefulness of the Model 103 is enhanced by its versatility:

NOISE can be improved by changing input impedance with a "Normal" and "Low Noise" switch. Chart below indicates noise levels with input shorted, gain 1000x, 10 cps to indicated cutoff:

BANDWIDTH can be selected by using 11 high and low frequency cutoffs between .1 cps and 100 kc.

INPUT IMPEDANCE in the "Normal" mode is 10 megohms; in the "Low Noise" mode, 100 k ohms.

AMPLIFIER GAIN may be set at either 100 or 1000 and adjusted to precise values.

INPUT CONNECTIONS can be made single-ended or differential.

DIFFERENTIAL REJECTION is at least 80 db permitting increased signal-to-noise ratios in many applications.

POWER—from batteries or the Keithley Model 1031, a separate, solid state power supply with noise characteristics equivalent to batteries.

PRICES: Model 103, **$245;** rack, **$255** 1031 Power Supply, **$245;** rack, **$255**

Frequency of high cutoff point	Maximum noise, microvolts RMS referred to input	
	Normal (10 meg impedance)	Low Noise (100 k impedance)
100 kc	3.0	1.9
30 kc	1.9	1.1
10 kc	1.4	0.8
3 kc	0.9	0.6
1 kc	0.7	0.4
300 cps	0.5	0.3
100 cps	0.4	0.25

This oscillograph shows a 2 kc square wave of 5 microvolts peak-to-peak amplitude at input with the amplifier in "Low Noise" position. Horizontal calibration equals 200 μv per division; vertical equals 2 μv per division. Low cut is 10 cps, high cut 1 kc. The unusually low noise levels in the 103 are achieved through the use of ceramic tubes in cascode circuitry.

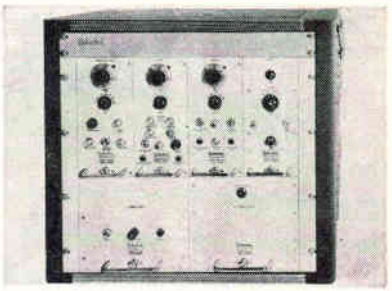
Send for complete specifications in latest engineering note . . .

KEITHLEY INSTRUMENTS
12415 EUCLID AVENUE CLEVELAND 6, OHIO

electrometers • micro-microammeters • microvoltmeters • milliohmmeters

ature preamplifier with bandwidth over 1 Mc is suitable for increasing the sensitivity of laboratory instruments, electronic devices, mechanical pickup or transducers.

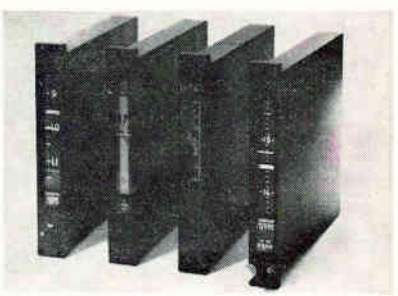
CIRCLE 340 ON READER SERVICE CARD



Modular Systems
PULSE & TIME DELAY

RUTHERFORD ELECTRONICS CO., 8944 Lindblade St., Culver City, Calif. Designed on the modular building block concept, a complete line of repetition rate, delay, width, pulse forming, and power supply packages will make possible a new line of standard pulse and time delay generators, as well as giving the company the ability to easily build up special purpose generators to meet any pulse requirement.

CIRCLE 341 ON READER SERVICE CARD



Instrument Indicators
BOOKSHELF TYPE

KOLLSMAN INSTRUMENT CORP., Elmhurst, N. Y. Instrument indicators built as separate vertical parameters promise high readability and compactness for aircraft cockpit instrument panels. Shown are four units—a Mach-indicated air speed indicator, an indicator of angle of attack and acceleration, a vertical speed (rate-of-climb) indicator and an altitude indicator—each measuring 1 1/8 in. wide and designed to be mounted side-by-side as a single unit.

CIRCLE 342 ON READER SERVICE CARD

PRODUCT BRIEFS

IMPACT NOISE ANALYZER push-button resetting. General Radio Co., West Concord, Mass. (343)

SILICON RECTIFIERS double-diffused. Solitron Devices, Inc., 500 Livingston St., Norwood, N. J. (344)

SMALL MOTORS unidirectional, nongeared. Barber-Colman Co., Rockford, Ill. (345)

PRESSURE SWITCH military-industrial. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. (346)

TINY LAMP twin filament. Chicago Miniature Lamp Works, 1500 No. Ogden Ave., Chicago, Ill. (347)

COIL BOBBIN one-piece laminated glass cloth. Silicone Insulation, Inc., 1383 Seabury Ave., Bronx 61, N. Y. (348)

CERAMIC CAPACITORS 50 and 200 vdcw. Aerovox Corp., Olean, New York. (349)

POWER SUPPLY for variable purpose use. Chalco Engineering Corp., 15126 South Broadway, Gardena, Calif. (350)

BERYLLIUM ANALYZER for lab use. Kleber Laboratories, Inc., 2530 N. Ontario St., Burbank, Calif. (351)

ACCELEROMETER SWITCH ruggedized. Humphrey, Inc., 2805 Canon St., San Diego 6, Calif. (352)

INSULATING COATING high temperature. Columbia Technical Corp., Woodside 77, N. Y. (353)

SET/RESET INDICATOR plug-in module. Electronic Control Products, U.S. Highway 22, P.O. Box 286, Dunellen, N. J. (354)

C-C TV CAMERA uses 7-tube circuit. Marsan Industries, Inc., 49 Edison Place, Newark, N. J. (355)

PORTABLE OHMMETER accurate to 0.5 percent. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. (356)

TIME DELAY SWITCH small, rugged. Inertia Switch, Inc., 311 W. 43rd St., New York 36, N. Y. (357)

PHASE CHECKER sound-powered. Radio Corp. of America, Harrison, N. J. (358)

Literature of the Week

ELECTRONIC TIMERS Electronic Products Corp., 4642 Belair Road, Baltimore 6, Md. Literature contains specifications, photos and prices on an assortment of transistorized timing devices. (359)

FEED-THROUGH CAPACITORS Fansteel Metallurgical Corp., North Chicago, Ill. Data sheet describes 1.0-amp feed-through, solid tantalum capacitors. (360)

EPITAXIAL TRANSISTOR Radio Corp. of America, Somerville, N. J. Four-page bulletin announces the 2N828 germanium epitaxial mesa transistor. (361)

MICROWAVE DIODES Sylvania Electric Products Inc., 100 Sylvan Road, Woburn, Mass., has available a 26-page microwave diode product guide. (362)

STRAIN GAGES Baldwin - Lima-Hamilton Corp., Waltham 54, Mass. A data sheet describes a line of weldable strain gages. (363)

SEALANT American Sealants Co., 705 N. Mountain Road, Hartford 11, Conn., has published a memorandum on the approval of Loctite sealants for use in military electronic equipment. (364)

MAGNETIC HEADS International Electro-Magnetics, Inc., Box 7, North Chicago, Ill. Folder contains typical configurations and specification considerations for magnetic heads. (365)

RFI SUPPRESSORS Relcoil Products Corp., Spring St. & Route 75, Windsor Locks, Conn. Four-page folder covers a line of r-f noise suppressors. (366)

TEST TERMINATIONS Holland Electronics Inc., 772 E. 53rd St., Brooklyn 3, N. Y., offers two bulletins describing a line of precision test terminations for pulse, video and r-f applications. (367)

CARD RECEPTACLES Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago 31, Ill. Bulletin R9-261 describes the FD-900 and SMI-600 Reli-Acon printed circuit card receptacles. (368)

TELEMETRY PREAMPLIFIER Defense Electronics, Inc., 5451-B

Randolph Rd., Rockville, Md. Data sheet illustrates and describes model TPA-1 telemetry preamplifier. (369)

PLUG-IN CHOPPER Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif., has available literature describing model 66 plug-in line-driven chopper (or modulator). (370)

STANDBY A-C POWER SYSTEMS Electro-Seal Corp., Des Plaines, Ill. Bulletin 6131 describes the Electro-Pac "A" standby a-c power systems. (371)

ZONE SCANNERS Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill., has issued bulletins showing the features and capabilities of two zone scanners. (372)

FILTERS Stancor Electronics, Inc., 3501 W. Addison St., Chicago 18, Ill. Bulletin discusses typical MIL-F-18327A filters. (373)

SOLID STATE AMPLIFIER Neff Instrument Co., 1088 E. Hamilton Rd., Duarte, Calif. Four-page bulletin describes a reliable open-loop d-c amplifier. (374)

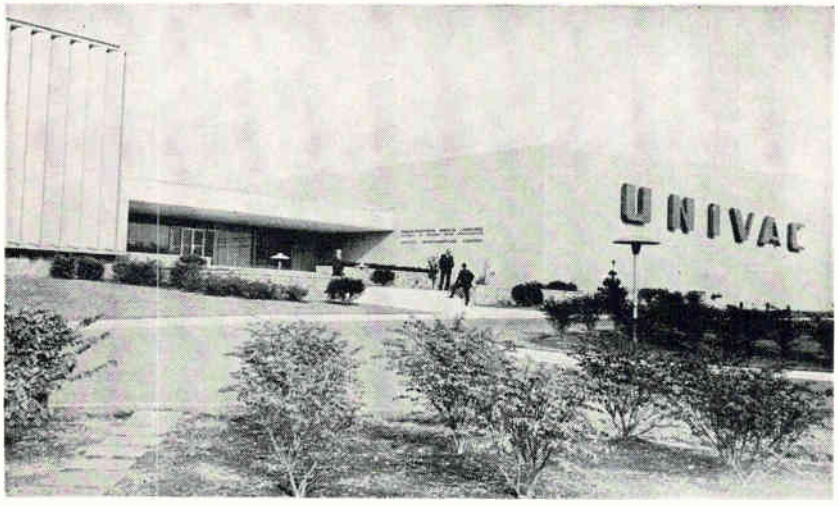
DIGITAL CIRCUITRY Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif., has available a 68-page handbook covering applications of digital circuitry. (375)

FIELD EFFECT TRANSISTORS Texas Instruments Inc., P.O. Box 5012, Dallas 22, Texas. Unipolar field effect transistor characteristics and applications are discussed in a technical information bulletin. (376)

NOISE CONTROL H. H. Scott, Inc., 111 Powdermill Rd., Maynard, Mass. Booklet entitled "The Why and How of Noise Control" discusses fundamentals of industrial noise control. (377)

CUSTOM SYSTEMS CAPABILITIES Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif. Brochure contains a summary of the company's operating methods, an explanation of its organizational divisions and examples of its projects. (378)

WAVEGUIDE PRESSURE WINDOWS Microwave Development Laboratories, Inc., 15 Strathmore Road, Natick, Mass. Catalog WD-61 contains electrical and mechanical data for a line of waveguide pressure windows. (379)



Univac Dedicates $20-Million Center

DISCOVERY of better ways to build electronic computers is the purpose of the new Univac Engineering Center recently dedicated in Whitpain Township, Pa. The center represents an investment of $20 million by the Sperry Rand Corp., of which Remington Rand Univac is a division.

At the new center, on a 112-acre tract, more than 700 engineers, scientists and technicians are engaged in basic and advanced research, product design, quality assurance and human engineering. There are some 25 separate laboratories for such fields as the chemistry of magnetic materials and solid-state physics.

Among new techniques being developed are, for example, the use of fluids as amplifiers and digital logical devices.

Work in the plating laboratory is opening the way to extreme high pulse densities on magnetic drums and tapes. From these new techniques, Univac scientists foresee smaller memory devices with larger capacities.

Research in mass storage devices at the center gives promise in the near future of four to 10 times the capacities and speeds of present components, company says. Other research, in the software field of English and mathematical languages, involves over 80 projects in four main areas: product design, systems programming, R&D, and government projects.

Univac engineering centers are also located in St. Paul, Minn., and Norwalk, Conn. Basic research on a corporate-wide basis is conducted at the new Sperry Rand Sudbury Engineering and Research Center in Sudbury, Mass.

Jackson Moves Up At Ryan Aeronautical

ELECTION of Robert C. Jackson as president of Ryan Aeronautical Co., San Diego, Calif., to be effective Nov. 1, has been announced by T. Claude Ryan, chairman of the board.

Ryan, who has held the positions of president and chairman, continues as chairman of the board and chief executive officer. Jackson has been the company's executive vice president for the past two years.

Colorado Instruments Hires R. E. Howard

RICHARD E. HOWARD has joined the staff of Colorado Instruments, Inc., Broomfield, Colo., as senior engineer. His background includes five years with Colorado Research Corp., where he was assistant manager of engineering, and three and one-half years with Denver Research Institute of the U. of Denver.

Colorado Instruments designs and manufactures digital electronic instruments, controls, and image transmission systems. Firm also conducts general electronic systems research and development work.

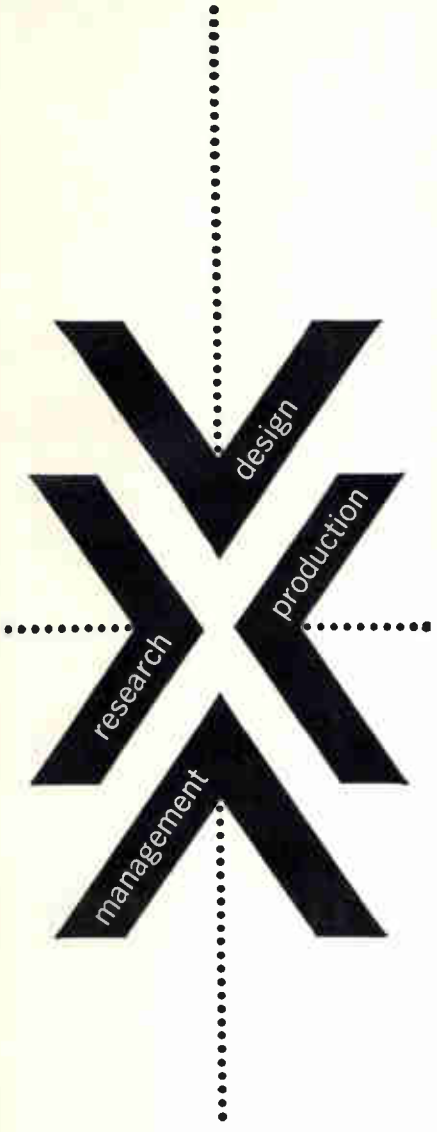
Quantatron Elects Maiman a V-P

ELECTION of Theodore H. Maiman as a vice president of Quantatron, Inc., is announced.

For six months before this appointment he held the post of director of the applied physics laboratory in this Santa Monica applied science company. Current activity of the laboratory embraces the entire spectrum of lasers from basic materials research to systems application.

Burnell Names Lab In Guillemin's Honor

THE GUILLEMIN RESEARCH LABORATORY of Burnell & Co., Inc., of Pelham, N.Y., which was recently formally dedicated in Cambridge, Mass., honors the name of Ernst A. Guillemin, Webster professor of electrical engineering at MIT, and a vice president and director of re-



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10^{-10} VACUUMS...IN THE FIELD!

If you've been baffled by the problem of maintaining high vacuums under field conditions, Varian can supply the answer—the Battery-Operated VacIon® Pump Power Supply.

This DC-DC converter unit employs a combination of transistor and magnetic circuitry. VacIon all-electronic high vacuum pumps can be operated wherever a 12V power source is available. Designed for use with VacIon pumps from 0.2 to 8 litres/second pumping speed.

Here's a low-cost means of low-pressure appendage pumping (under ideal conditions, up to 10^{-10}mm Hg) in situations where normal sources are unavailable: during shipping, in-plant movement, standby operation, or at remote field locations. Compact, rugged, shockproof. Operable at temperatures from 0°F to 150°F, at humidities up to 100%.

For full technical data, write Vacuum Products Division.

VARIAN associates

PALO ALTO 1, CALIFORNIA

BOMAC LABORATORIES, INC.
VARIAN ASSOCIATES OF CANADA, LTD.
S-F-D LABORATORIES, INC.
SEMICON ASSOCIATES, INC.
SEMICON OF CALIFORNIA, INC.
VARIAN A. G. (SWITZERLAND)

search of Burnell & Co. Burnell manufactures electronic filter networks, delay lines and related components.

An authority and consultant on communications and electronic network analysis, Guillemin has been a member of the MIT faculty since 1928. He was advanced from professor of electrical communications to the Webster chair in March, 1960, the seventh man to be selected for the honor.

Last March, Guillemin received the 1961 Medal of Honor of the IRE. He also holds a Presidential Certificate of Merit for his work during World War II.

Gross Heads Up New Company

FORMATION of Spectran Electronics Corp., Maynard, Mass., for the development and manufacture of magnetostriction components and instruments has been announced by its six founders.

Heading the Spectran group is T.A.O. Gross, president. Frank R. Stevens is vice president and treasurer; Edward J. Neville, Jr., vice president of manufacturing; James C. Davis, Jr., chief engineer; Frederick C. Hawkes, head of physical metallurgy. All the above were formerly with Raytheon.

Completing the founding group is Garland L. Tomlin, Jr., director of design activities. He was formerly with Microwave Associates.

Rothstein Assumes New Position

JEROME ROTHSTEIN has been named vice president and chief scientist for Maser Optics, Inc., Cambridge, Mass. The position is a new one in the recently formed company, which performs research and development

in the field of lasers and coherent optics.

Rothstein was formerly senior scientific executive for Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

DeWitte Joins EOS As Research Scientist

SERGE DEWITTE has joined Electro-Optical Systems, Inc., Pasadena, Calif., as a research scientist in the materials research department of the Quantum Physics division. He will investigate laser and maser materials.

Prior to joining EOS, DeWitte was with Pacific Semiconductors, Inc.

PEOPLE IN BRIEF

Philco Corp.'s Computer div. has promoted **Robert A. Leithman** to manager of quality assurance. **Stephen A. Keller**, formerly with Electric Autolite Co., named executive v-p of Telex, Inc. **Robert S. Donnelly**, ex-Federal Electric Corp., appointed assistant to the president of Northeastern Engineering, Inc. **Marcos E. Ruiz** leaves RCA to join the engineering staff of Instrument Corp. of Florida. **Leon Lerman** advances at Sylvania to product manager—commercial twt's for the Microwave Device div. The Daven Co. elevates **Richard J. Newman** to director of planning and development. **Walter D. Heisler**, formerly of Airpax Electronics, has joined Cambridge Scientific Industries as sales manager. **David C. Goldberg** and **Roger A. McIntyre** move up to director and associate director, respectively, at Westinghouse's new space materials dept. **Jerald R. Haegele**, of Eitel-McCullough, Inc., named manager of the company's newly created Accessory Products div. **Leland A. Sidwell** promoted to v-p and manager of the Connector Division of Microdot Inc. RCA ups **Lawrence M. Falk** to the post of manager, support engineering, in the data communications and custom projects dept. of its Electronic Data Processing div.

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.

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5. Fill out the form completely. *Please print clearly.*
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ESQUIRE PERSONNEL Chicago, Illinois	137	2
HUGHES AIRCRAFT COMPANY Tuscon Engineering Lab. Tuscon, Arizona	111	3
INTERNATIONAL NICKEL CO., INC. New York, New York	137	4
LOCKHEED CALIFORNIA CO. A Div. of Lockheed Aircraft Corp. Burbank, California	21	5
LOCKHEED MISSILES & SPACE CO. A Group Div. of Lockheed Aircraft Corp. Sunnyvale, California	22, 23	6
McDONNELL St. Louis, Missouri	85*	7
NATIONAL CASH REGISTER CO. Electronics Division Hawthorne, California	60	8
NATIONAL CASH REGISTER CO. Dayton, Ohio	86*	9
SANDERS ASSOCIATES INC. Nashua, New Hampshire	84*	10
UNION CARBIDE NUCLEAR CO. Oak Ridge, Tennessee	84*	11

*These advertisements appeared in the 11/3/61 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

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NAME .....

HOME ADDRESS.....

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

HOME TELEPHONE.....

Education

PROFESSIONAL DEGREE(S).....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

11101

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

ANTENNA PEDESTAL SCR 584—MP 61B

Full azimuth and elevation sweeps 360 degrees in azimuth. 210 degrees in elevation. Accurate to 1 mil. or better over system. Complete for full tracking response. Angle acceleration rate: AZ, 9 degrees per second squared EL, 4 degrees per second squared. Angle slewing rate: AZ 20 degrees per sec. EL. 10 degrees per sec. Can mount up to a 20 ft. dish. Angle tracking rate: 10 degrees per sec. Includes pedestal drives, selsyns, potentiometers, drive motors, control amplidynes. Excellent condition. Quantity in stock for immediate shipment. Ideal for missile & satellite tracking, antenna pattern ranges, radar systems, radio astronomy, any project requiring accurate response in elevation and azimuth.
Complete description in McGraw-Hill Radiation Laboratory Series, Volume 1, page 284 and page 209, and Volume 26, page 233.

MIT MODEL 9 PULSER
1 MEGAWATT-HARD TUBE

Output pulse power 25 KV at 40 amp. Max duty ratio: .002. Uses 6C21 pulse tube. Pulse duration .25 to 2 microsec. Input 115 volts 60 cycle AC. Includes power supply in separate cabinet and driver. Fully guaranteed as new condition. Full Desc. MIT. Rad. Lab. series "Pulse Generators."

MIT MODEL 3 PULSER

Output: 144kw (12kv at 12 amp). Duty ratio: .001 max. Pulse duration: .5 1 and 2 micro sec. Input: 115v 400 to 2000 cps and 24vdc. $325 ea. Full desc. Vol. 5 MIT Rad. Lab. series pg. 140.

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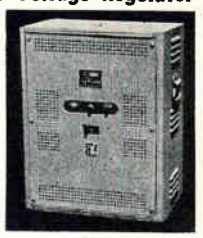

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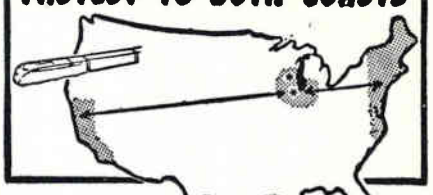

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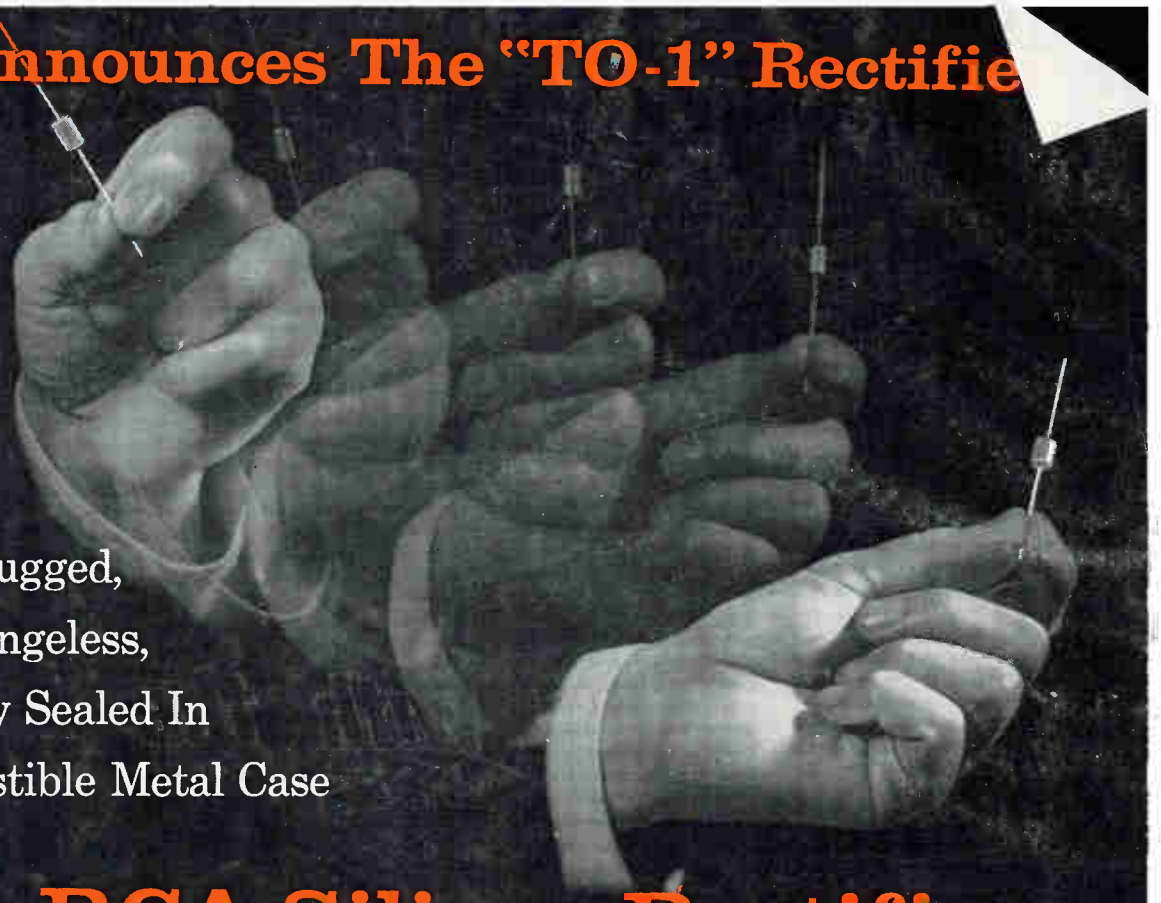
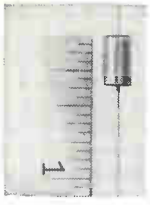


New Tiny, Rugged,
Tubular, Flangeless,
Hermetically Sealed In
Non-Combustible Metal Case

4 New RCA Silicon Rectifiers

for Industrial Applications
¾ Amp. from 200 to 600v–½ Amp. at 800v.



Here's RCA's brand-new idea in rectifier case design—four new silicon rectifiers in hermetically sealed flangeless metal packages. These four new types now make silicon rectifiers as easy to handle and mount as other standard tubular components. They are designed to outperform plastic-packaged rectifiers and meet the stringent heat and humidity requirements of today's industrial and commercial applications.

Using a unique combination of a silicon diffused-junction and a new case, these units can be operated at temperatures up to 75°C without derating. They are designed and priced to bring you economy and performance plus easy handling and assembly.

Sample these new RCA SILICON RECTIFIERS yourself and put them to work in your product. Call your RCA representative today at the Field Office near you. For additional technical information, write RCA Semiconductor and Materials Division, Commercial Engineering, Section K-19-NN-2, Somerville, N. J.

Available Through Your RCA Distributor

RCA ®
The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

RCA "TO-1" SILICON RECTIFIERS

Type	Max Ratings PIV	Max. Ratings Forward Current * @ 75 °C	Max Ratings Recurrent Peak Current @ 75 C	Max Instantaneous Forward Voltage Drop @ 0.5 DC amp. @ 25 °C	Max. Reverse Current @ 25 °C and rated PIV
1N3193	200 v	750 ma	6 amp	1.2 v	10 μa
1N3194	400 v	750 ma	6 amp.	1.2 v	10 μa
1N3195	600 v	750 ma	6 amp.	1.2 v	10 μa
1N3196	800 v	500 ma	5 amp.	1.2 v	10 μa

*Resistive or inductive load

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New...
RCA'S TO-1 Rectifiers Are Now Available in Clear Plastic High-Dielectric-Strength Insulating Sleeves

RCA-1N3253
200V PIV, 750 ma insulated version of RCA-1N3193

RCA-1N3254
400V PIV, 750 ma insulated version of RCA-1N3194

RCA-1N3255
600V PIV, 750 ma insulated version of RCA-1N3195

RCA-1N3256
800V PIV, 500 ma insulated version of RCA-1N3196