November 24, 1961

electronics

A McGraw-Hill Publication 75 Cents

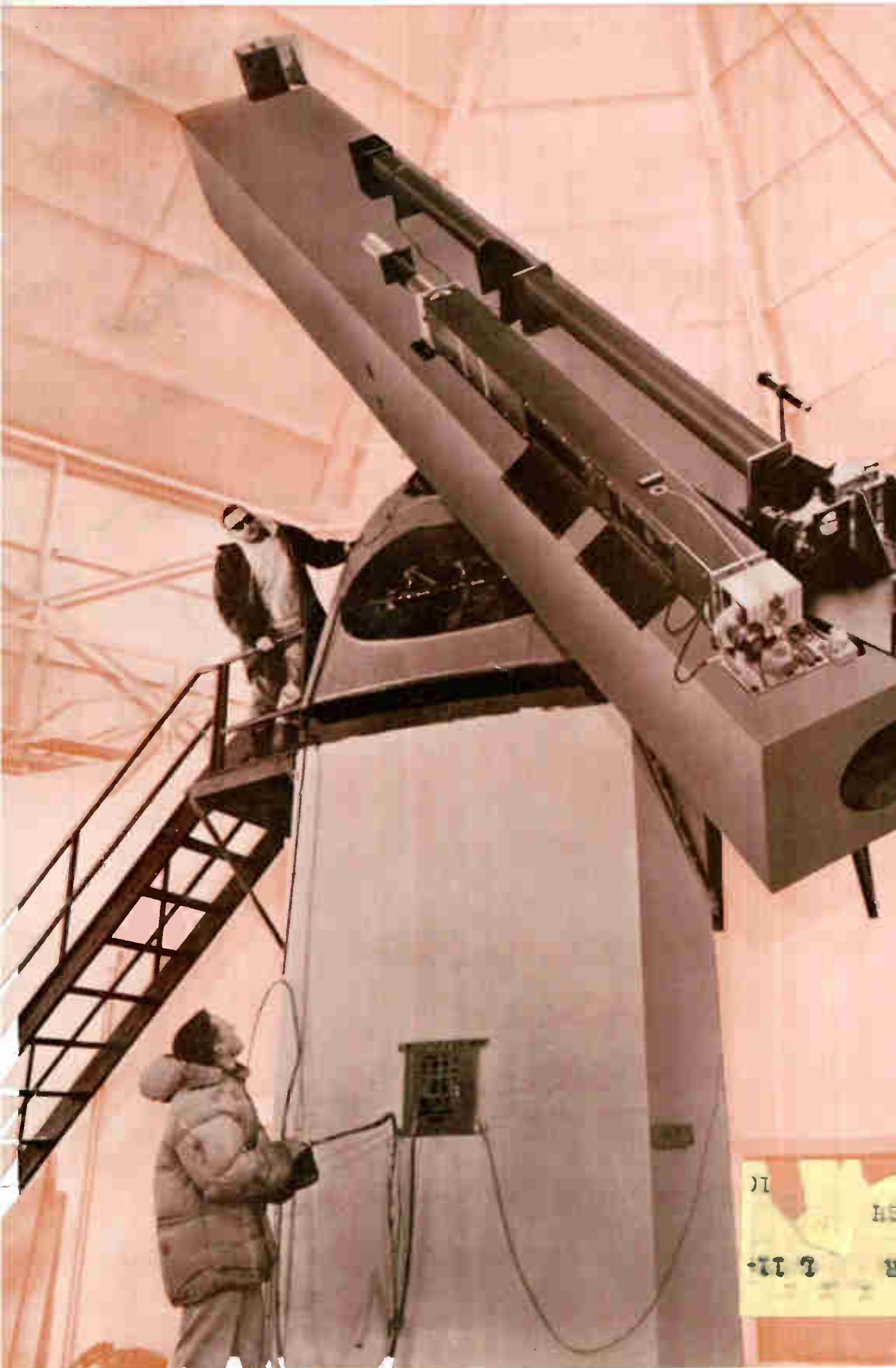


Photo at left

POLARIZING CORONAMETER

analyzes sun's outer electron corona, p 58

TUNNEL DIODES

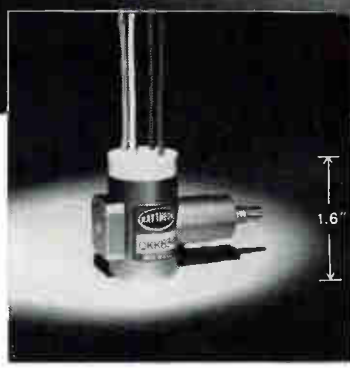
form low-level triggers, p 52

CRYOGENICS

45

K_a-BAND KLYSTRON OSCILLATOR, QKK 834, shown with 90° (above) or 180° (right below) positioning of tuner. **Above photo is actual size.**

New klystrons hold characteristics in grueling aerospace environments



K_a- and K-band tubes are tunable from 34.0 – 35.6 and 23.5 – 24.5 kMc

Now, Raytheon combines the advantages of small size, extreme ruggedness, thermal stability, and smooth wide-range tunability in a 20mW reflex klystron.

The new QKK 834 for K_a band and QKK 923 for K band are all ceramic and metal tubes with typical electronic tuning range of 110 Mc. The tuner, utilizing a sapphire rod, can be specified for positioning anywhere on the circumference of the resonator at least 90 degrees from output flange (see illustrations above). Write today for detailed technical data or application service to Microwave & Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

QKK 834, QKK 923 — GENERAL CHARACTERISTICS	
Power Output	20 mW (nominal)
Frequency	34-35.6*; 23.5-24.5† kMc
Resonator Voltage	400 V
Reflector Voltage Range	—65 to —175V
Temperature Coefficient	± 0.5 Mc/°C
Cooling	convection (no blower needed)
Overall Dimensions	1 5/8 x 1 1/16 x 2 in.*

*QKK 834 †QKK 923

RAYTHEON COMPANY

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

CIRCLE 251 ON READER SERVICE CARD

November 24, 1961

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

Of course—but they are much broader than you might think. The illustrated units are just a few of the difficult and unusual switches that CENTRALAB has been called upon to design.

What kind of special switch do you need? CENTRALAB engineers can modify an existing type, or design an entirely new switch to solve your problems.

For immediate attention, write directly to CENTRALAB'S Switch Sales Manager, outlining your problem.

1. Switches 36 circuits progressively in missile check-out application. Used with stepping relay in limited equipment area. Glass silicone insulation.
2. Sub-miniature 24 position switch provides 50% space reduction over conventional switch construction. Has rugged, accurate indexing for long life. Glass epoxy insulation.
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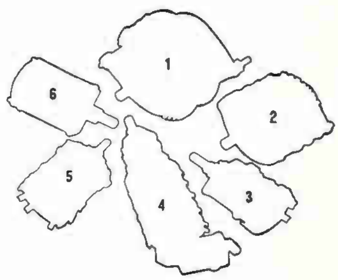
4. 5 pole, 9 position low voltage switch with locking action make and break on integral snap action switch. Snap action switch breaks load to rotary switch during switch cycle.
5. Dual concentric switch in which inner shaft operates rotors of all 3 sections while outer shaft operates rotor on front section independently. Used in aerial photography equipment.
6. 3 pole, 18 position unit with 6 positions on each section. Has high torque for positive positioning of contacts. Glass epoxy insulation. Used in ground support equipment.



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1962 1963 1964 1965 1966

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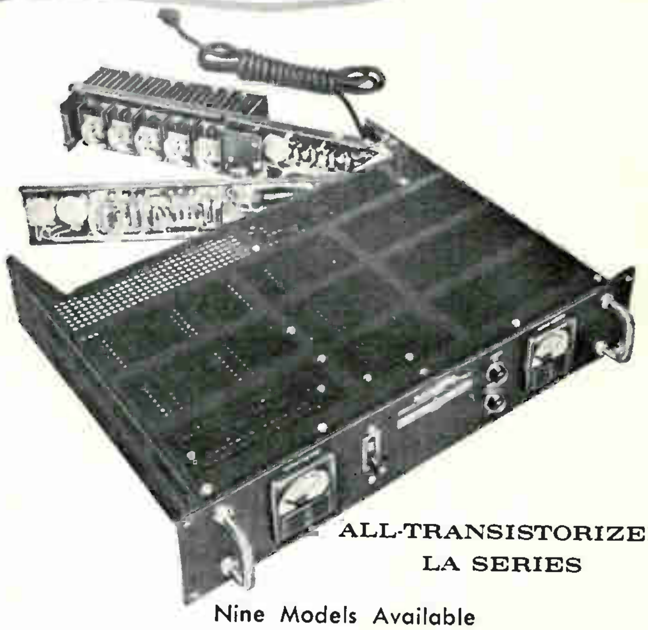
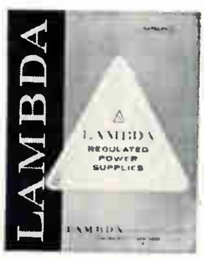


Every Lambda power supply carries a written guarantee that it will perform to specifications for five full years. You can install power supplies now with complete assurance that they will still perform to design standards in 1966. *Lambda's guarantee, which covers workmanship and materials (except for tubes and fuses), has been in effect on all power supplies sold since 1953.* It is your strongest assurance of power supply performance in installations where dependability is an absolute necessity for round-the-clock, heavy-duty service.

SEND FOR NEW LAMBDA CATALOG 61



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CIRCLE 3 ON READER SERVICE CARD

electronics
November 24, 1961 Volume 34 No. 47

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CROSSTALK

Needling the Needlers

SOME ASTRONOMERS think the West Ford project to orbit a belt of "needles" in space will interfere with their observations; the people putting them up there say they will not, and that even if they did it would not be for long. Some radio men wonder if the little dipoles might upset normal long-distance shortwave communications; there is no sign of it so far and very little information, in fact, about their efficiency as reflectors even at the frequency to which they are tuned.

If these were normal times there might be more justification for studying possible undesirable side effects longer before aiding nature. But with 50-megaton bombs going off and neutron bombs under consideration these are not normal times. The security of the country obviously must have higher priority than astronomical observations, or even business-as-usual communications. And it might be that giant atomic explosions preceding an actual attack and set off expressly for this purpose could temporarily knock out much of our communications.

Communications represents one of our strongest cards in any conflict, or our Achilles heel if we suddenly find ourselves without them. Projects like West Ford, and experimentation with satellites of many kinds, are necessary if we are to have a communications system immune to blackout. No other justification for current experiments is necessary.

GREMLINS. One of our top military communications-electronics officers remarked the other day that radio frequency interference is the "gremlin of all gremlins", capable of making a vital battlefield message unintelligible. On p 38, Midwest Editor Wiley reports recent progress in establishment of what the military services hope will be one of the chief weapons against rfi—the new Electromagnetic Compatability Analysis Center at Annapolis, Md.

Coming In Our December 1 Issue

SOUND SYNTHESIZER. New musical effects can be created with a sound synthesizer described next week by H. Bode, of The Wurlitzer Co. He shows how well-known electronic circuits can be used in various system combinations to produce unconventional sounds and patterns from ordinary audio. Other feature articles include: a scanner that analyzes the color content of movie film, by R. J. Farber and K. M. St. John of Hazeltine Research Corp.; a subaudio sawtooth generator that gives one-percent linearity, by A. Angelone of Ohio State University; and a survey of seven ways to use cobalt in electronics parts, by F. R. Morral of Battelle Memorial Institute.

COMMENT

Semiconductors

The recent article on What's New in Semiconductors (Sept. 29, p 89) is an extremely sweeping survey of the semiconductor field. For people with some familiarity in the field it certainly will serve as a useful guide as to progress being made in the semiconductor industry.

As to the remarks about the purity of the silicon now commercially available, the great improvement recently made by suppliers of silicon crystals in controlling impurities has made possible the supply of *p*-type crystals of 1,000 ohms per cm or better on a regular basis.

This has permitted our company to fabricate a device not mentioned in your survey, the silicon nuclear particle detector. This device depends on the existence of a space-charge region as deep as possible. Since in an abrupt junction the space-charge region is proportional to the square root of the resistivity the availability of high-resistivity silicon was a critical problem until recently.

FRED P. BURNS
Solid State Radiations, Inc.
Los Angeles, California

National Electronics Conference

The board of directors and management of the National Electronics Conference wish to thank you for the very fine coverage given to us in the October 16 issue (p 61).

As you know, NEC is a non-profit organization devoted to the advancement of the art and science of electronics. The growth of NEC can be attributed to the volunteer assistance and very fine cooperation of the various electronics trade organizations and publications.

R. J. NAPOLITAN
National Electronics Conference, Inc.
Chicago, Illinois

Rectification Efficiency

Regarding the comments by reader Pinnell (*Comment*, Oct. 13, p 7) on my article Replacing Sine Wave Sources With Solid-State Inverters, the rectification efficiency of a sinewave voltage is not 100 percent as he states. The ratio of d-c power out to the total power in can be shown qualitatively to be less than 100 percent if you consider that the incoming a-c that is rectified does not become pure d-c, but rather a pulsating d-c containing pure d-c as well as a-c components.

Please note carefully that rectification efficiency is defined as the ratio of d-c output power to total input power. The rectified output is not pure d-c; hence, the efficiency as defined must be less than 100 percent by an amount proportional to the amount of a-c components contained in the rectified output.

This efficiency is in no way related to a power-loss efficiency of any kind. Normally, this efficiency of conversion is not of first-order importance; however, there are applications that depend upon having a high rectification efficiency, particularly if no filters are used to smooth the rectified a-c. One such application is in the electroplating field. The a-c components present in the output of rectified a-c do no useful work and appear as a heating loss. The plating operation is dependent on the pure d-c component.

DONALD LEVY
The Daven Company
Livingston, New Jersey

Reader Pinnell replies:

Author Levy is so right! With a resistive load, the theoretical efficiency of a full-wave rectifier, defined as the ratio of d-c output power to a-c input power, is 81 percent.

On the other hand, if a filter is incorporated so that no a-c ripple appears across the resistive load, the theoretical efficiency is 100 percent, assuming the filter to be lossless. Commercial battery chargers that have very low output ripple can deliver up to 95 watts of d-c for every 100 watts of a-c power in.

To be strictly correct, we must say that the rectification efficiency as defined depends on the load. If the a-c voltage components of the rectified wave are fed directly to the same resistive load, the theoretical efficiency is 81 percent, as you say. If a-c components are blocked from the load, theoretical efficiency reaches 100 percent.

STANLEY E. A. PINNELL
Pylon Electronic Development Company
Montreal, Quebec


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The seed will achieve its fullest potential when nurtured in the most receptive environment.
So, too, ideas.
If your ideas need a place in the sun, we would like very much to hear from you.
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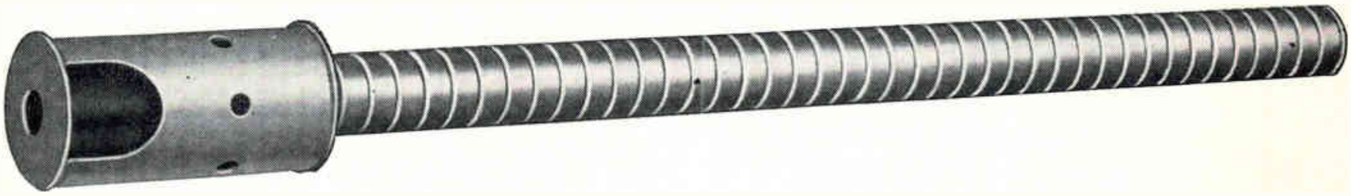

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TWT stacks are only one example of Indiana's leadership in magnetic experience, materials and equipment. Bring all your permanent magnet assembly problems to us for fast, efficient solutions. Write for Bulletins, describing INDOX VI-A — Alnico VIII.

INDIANA GENERAL CORPORATION
INDIANA STEEL PRODUCTS DIVISION, Valparaiso, Indiana

Lasers: Communications or Combustion?

REALLY SIGNIFICANT applications of lasers may evolve from their "fantastic" energy intensity, rather than coherence factors or communications possibilities, P. Franken, of University of Michigan, commented at the NEREM session on coherent light.

He told of burning a hole 2 mm wide in a tempered steel razor blade, with a medium-powered laser beam focused to a spot with intensity of 10^{8} w/sq cm. Other beams burned through steel 10 blades thick. (Use of laser beams for missile destruction was suggested in ELECTRONICS, p 4, Oct. 13.)

Franken warned that laser beams could be extremely dangerous to researchers. A beam can destroy the eyes; even reflected light would do severe damage.

C. H. Townes, provost of MIT, told ELECTRONICS, that in a few years optical maser techniques may be extended to the 1-0.01 mm region and perhaps also to short uv or X-ray. To go beyond 500 A without a new idea will be difficult, he said. Blue-green lasers may be reached in a year or two. He expects modulation at 1-10 Gc to come along rapidly.

In his prepared talk, Townes said it is difficult to tell yet if lasers will live up to their promise. He cited such potential characteristics as beam directivity of 10^{-7} radians in discussing possibilities of communicating over tens of light years and transmitting kilowatts of power over thousands of miles.

costs of some $300,000 during the past five years have been underwritten by related projects undertaken for Bell Helicopter Co., Army Rocket and Guided Missile Agency and Navy Bureau of Weapons.

Semiconductor Alloy Turns Heat to Power at 1,000 C

GERMANIUM-SILICON alloy which generates power at temperatures close to 1,000 C makes it possible to boost the efficiency of sandwich type thermocouples to 15 percent or more, RCA Labs reported last week.

A two-element thermocouple made of a $\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4}$-in. cube of the alloy produced 2.4 watts with an efficiency of nine percent when heated to 900 C in the laboratory. This corresponds to a power density of 5-10 Kw/sq ft. Average figure of merit for n-type material is 0.9 $\times 10^{-3}$ deg^{-1} over the range 350-900 C. P-type averaged 0.6.

RCA claims previous semiconductors were limited in use to lower temperatures. The new alloy can utilize heat from flames, solar radiation and nuclear reaction, RCA says.

NEMA Sees $25 Billion Electrical Sales in '62

SHIPMENTS of electrical products should hit a record $25 billion next year, A. D. R. Fraser, outgoing president, predicted at National Electrical Manufacturers Association's 35th annual meeting in New York.

The forecast includes five percent gains for electronics, insulating materials, wire and cable, and three percent gain for communications equipment.

Homer L. Travis, of Kelvinator division of American Motors, was elected to succeed Fraser as president. Fraser heads the Rome Cable division of Alcoa.

USIA Reinforces Network With Flyable Transmitters

U. S. INFORMATION AGENCY will increase flexibility of its Voice of America radio network—now 87 transmitters at 17 locations—with four transportable 50-Kw radio transmitters. Three will be short wave, the other medium wave.

The four-unit facility is to be built to fit into vans, so it can be

Radar Measures Winds by Acoustic Wave Reflection

METHODS of determining wind velocity and turbulence with radar are reported by Midwest Research Institute, Kansas City. By detecting radar waves reflected from acoustic waves in the atmosphere, MRI says, velocities can be measured with accuracy of one mph. Range at present is 1,600 feet.

Technique can be used to analyze winds prior to rocket launches, to guide aircraft carrier landings and for other applications. Research

How to Snafu a Missile: Call a Taxi

THIS STORY was told at an Engineering Management Section meeting of the IRE in New York last week:

A missile continually malfunctioned during tests at Cape Canaveral. Investigation proved that interfering signals were coming from a two-way radio used by a dispatcher in Austin, Texas, to give assignments to taxi drivers.

The anecdote illustrated a point made by Joseph H. Vogelman, head of Capehart's interference countermeasures team and former communications director at Rome Air Development Center:

"Untold millions of dollars—and a tremendous amount of precious time—are being lost each year in this nation's defense and space effort because of radio frequency interference."

He urged management to consider rfi problems and solutions first. Building the hardware first and then testing for rfi is a "grave mistake," he said.

moved by air, land or sea and be operational in 30 days. Alpha Corp., a Collins Radio division, is contractor, at $1.4 million.

USIA plans to use the station first near Monrovia, Liberia, until a fixed station is completed in 1963. That will have six 250-Kw and two 50-Kw stations. Other steps to strengthen VOA include a 4.8-Kw transmitter complex near Greenville, N. C., land-basing a transmitter now carried on a ship in the Mediterranean, and increasing power of an English station leased from BBC.

Computer Tells Fighter Pilots Where to Strike

AIR FORCE Electronic Systems Division reports its Time Division Data Link system has proved out in 18 months of testing. The system automatically guides interceptor planes to targets.

Ground-based Sage computer calculates commands for an aerial battle and distributes them to transmitters which beam coded data to aircraft. Airborne equipment reconverts the code and pilot gets the picture on a panel display.

A-Bomb Worries Boost Radiation Kit Sales

FAMILY FALLOUT radiation kit sales should hit one million in 1962, says Landsverk Electrometer. The company has already distributed 1,000 kits selling under $35, has geared production to 5,000 a month and plans to double that in January.

The kit consists of a ratemeter measuring in roentgens hourly accumulation of radiation, a dosimeter to measure total exposure and a transistor battery-powered charger. Each meter is 4½-in. long and ½-in. in diameter; the charger is 4-in. square. Landsverk is also making a military version.

Microwave Radiometer Surveys Forest Fire

CANYON FIRES which recently destroyed many residences near Los Angeles were kept under surveillance by a sensitive microwave radiometer (ELECTRONICS, p 72, May 12) used as a camera. R. M. Stewart, of Space-General Corp., told the Institute of Aeronautical Sciences meeting in Los Angeles last week that an airborne system helped firemen fight the blaze. The radiometer located flame paths and hot spots through smoke dense enough to block visible light rays and infrared, it was reported.

Navy Launches Transit And Traac Satellites

TRAAC, a new satellite designed to test if the earth's gravity gradient can be used for attitude control, was launched piggyback with a Transit 4B satellite last week. Traac (Transit Research and Attitude Control) looks like a doorknob, trailing a long boom to distribute its mass.

If passive gravity control works, it would greatly simplify satellite systems, reduce power requirements and lengthen life. Satellites would always face earth, like the moon, allowing antennas and signal power to be concentrated on one side.

Transit 4B is the fourth of the navigational satellites in orbit. Navy hopes to have its worldwide navigational system, based on satellite fixes, operational by the fall of 1962.

Phase Shifting Reduces Speech Recognition Logic

IBM'S LATEST experimental speech recognition machine uses only two logic elements for each word recognized. It has 31 transistors and detects 16 words (digits 1 to 0, plus six command words). A 1,000-word device using 2,000 logic elements is believed feasible.

Key circuit identifies voicing, and to some extent vowels, according to asymmetry of the voicing waveform rather than frequency content. Asymmetry is enhanced by passing the speech wave through a phase shift filter. Sounds of the same frequency content tend to be very different in phase relationship.

In Brief . . .

AIR FORCE may establish research station near Perth, Australia, to study effect of space disturbances on communications.

APOLLO rocket contract will go to GE's Missile and Space department, reliable sources say.

ONE-MAN RADAR set, Silent Sentry, made by Sperry Gyroscope, is being sent troops in Germany. The portable unit uses audible signals, not display, to indicate targets.

GENERAL INSTRUMENT reports it has semimetal which will bond dissimilar metals and allow low-cost production of thermoelectric units.

ADMIRAL'S first radar bright display system is to become operational at Oakland ATC next week. It uses 945-line raster instead of 625 lines.

EIA REPORTS big jumps in production of stereo (328,045 units), radio (2,048,698) and tv (694,580) sets in September.

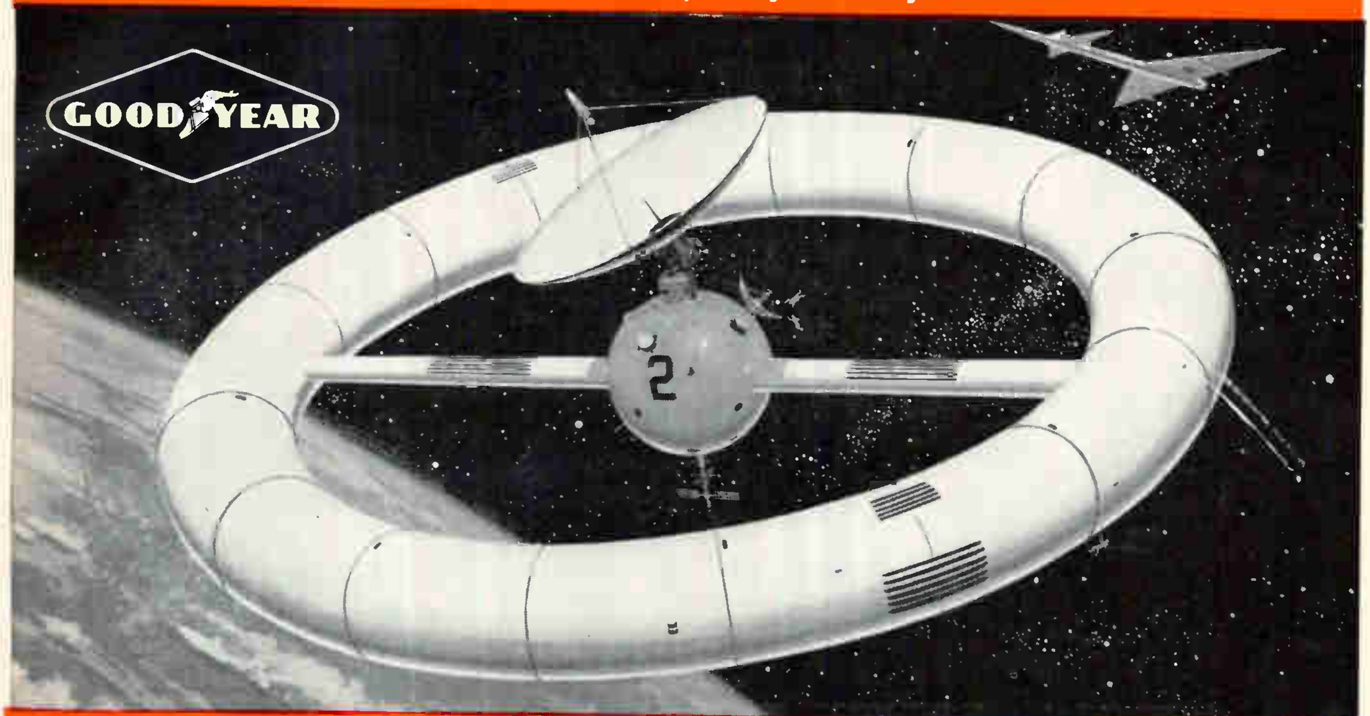
DIELECTRIC coatings for lasers give reflectance of 99.6 percent, are selective to specific frequencies and step up laser output power, Infrared Industries reports.

MAN-PACK thermoelectric generator with efficiency of 7 w/lb (250 w, 37 lb) has been delivered to Navy by 3M.

HUGHES has $2.8 million subcontract from Raytheon for work on Arpat study being made for ARPA under Project Defender missile defense.

OTHER DEFENSE contracts include $1.5 million to Beckman Instruments for Minuteman checkout gear; $1 million to Gulton Industries for Titan II components; $839,845 to ITT Communications Systems for analysis of the Defense Communications System; $766,587 to Northwestern Engineering for Air Force frequency counters; $500,000 to Electronic Specialty Co. for two 60-foot tracking antennas.

EXPANDABLE STRUCTURES: Another prime capability of Goodyear Aircraft



Way station to the stars, GAC-designed space structure, with solar collector and communications antenna, is completely expandable

HOUSING PROJECTS 500 MILES UP!

Expandable fabric structures for space missions inherently provide the advantages of minimum structural density, maximum volume/weight ratio, unmatched packageability on boost – making possible full-size erection and deployment in space with minimum launch penalty.

Expandable structures are being applied to a wide range of space applications – from manned space stations and ultra-lightweight solar concentrators to re-entry vehicles where aerospace engineers are applying new high-temperature, high-strength fabrics.

With 50 years of practical experience in developing specialized fabrics and fabric structures, Goodyear Aircraft is in a unique position to put this new technology to work at once. Whether the need is for a complete space system or major subsystems, GAC stands ready to utilize its unequaled facilities – research, engineering and production. If this new approach will help your project get off the ground, write Goodyear Aircraft Corporation, Dept. 914KK, Akron 15, Ohio.

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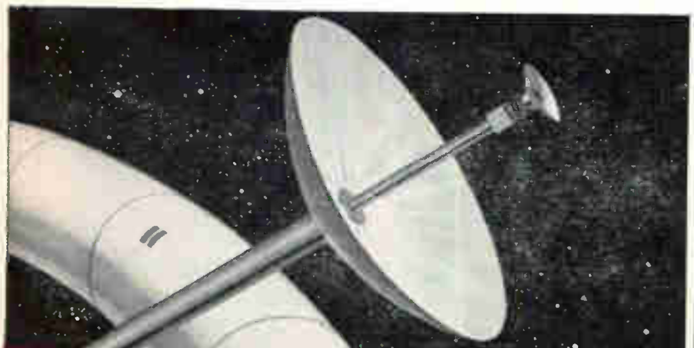
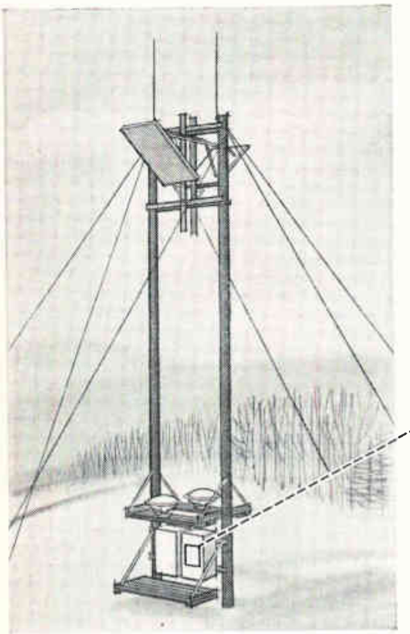
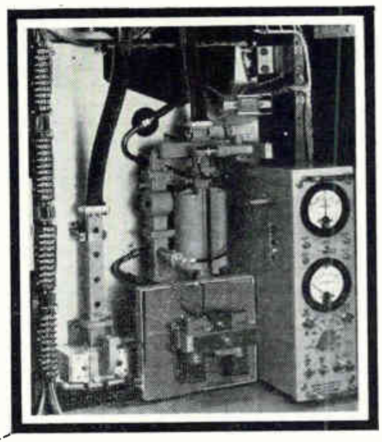


Solar concentrator with new "trumpet" condenser expands to 44½-ft. diameter. Design has been thoroughly tested for space environment.

Ballute recovery system, tested and proven in flight test, provides variable controlled drag for re-entry vehicle

Chemical Division 3M COMPANY





View of klystrons with protective cover removed. In this Western Electric Company equipment, temperature and frequency are stabilized by FC-75 Inert Liquid.

FC-75 keeps klystron "on the beam"!

Coolant stabilizes microwave frequency for −40 to +140°F ambient temperatures

A must for microwave communications equipment: a constant operating temperature for power-generating klystron tubes that assures unchanging frequency output. Now, with 3M Brand Inert Liquid FC-75, Bell Telephone Laboratories has developed for use in the new Western Electric TL Microwave Radio Relay System a stabilizing technique that saves space, money, and tames ambient temperatures over a 180-degree F. range.

The exceptional heat-dissipation properties of FC-75 permit use of a simple boiler-condenser cooling system that replaces space-consuming cooling oils, thermostats and blowers. And the klystron frequency is held within 0.05% over a −40 to +140° F. range in ambient temperature—*without* need for expensive frequency control circuitry.

With this new technique, heat generated by the klystron is absorbed by FC-75, causing it to boil. The FC-75 releases the heat and returns to a liquid state in the condenser tube, then drains back into the boiler. A rubber bag at the top of the condenser tube seals the system and expands or contracts as the FC-75 boils at varying rates in proportion to changes in ambient temperature. The pressure inside the boiler remains very close to atmospheric, which results in a constant boiling temperature.

FC-75 minimizes maintenance because it is non-corrosive and compatible with rubber, plastics, metals, other materials used in microwave equipment. It affords maximum safety because it is non-toxic, non-flammable, non-explosive. Its low pour point protects the boiler from freezing at the lowest expected ambient temperature. For additional details on FC-75 and its companion product, FC-43, see the profile at right.

PROPERTIES PROFILE

on 3M Brand Inert Liquids FC-75 AND FC-43

These unique dielectric coolants possess unusual properties that can prove advantageous to the designer of electrical devices and instruments, as well as to the manufacturer. Increased range of operating temperatures, improved heat dissipation which permits miniaturization, and greatly increased protection from thermal or electrical overload are possible with their use.

FC-75 and FC-43 are non-explosive, non-flammable, non-toxic, odorless and non-corrosive. They are stable up to 800°F., and are completely compatible with most materials... even above the maximum temperatures permissible with all other dielectric coolants. Both are self-healing after repeated arcing in either the liquid or vapor state.

ELECTRICAL PROPERTIES

	FC-75	FC-43
Electrical Strength	35KV	40KV
Dielectric Constant (1-40KC @ 75° F.)	1.86	1.86
Dissipation Factor (1000 cycles)	0.0005	0.0005

PHYSICAL PROPERTIES

	FC-75	FC-43
Pour Point	<−100°F.	−58°F.
Boiling Point	212°F.	340°F.
Density	1.77	1.88
Surface Tension (77°F.) (dynes/cm)	15	16
Viscosity (centistokes)	0.65 min.	2.74
Thermal Stability	750°F.	600°F.
Chemical Stability	Inert	Inert
Radiation Resistance	25% change @ 1 x 10^8 rads	25% change @ 1 x 10^8 rads

FC-75 and FC-43 have a nearly equivalent heat capacity in the liquid and gaseous state.

For more information on FC-75 and FC-43, write today, stating area of interest, to: 3M Chemical Division, Dept. KAX-111, St. Paul 6, Minn.

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WASHINGTON OUTLOOK

IN THE FACE OF increasing protectionist sentiment in electronics and other industries, the Kennedy administration is working up a freer trade policy which would mean more tariff cuts and a greater flow of imports.

The White House has just about decided to overhaul the Reciprocal Trade Act next year. The President wants broad authority to offer reciprocal tariff cuts on wide categories of industrial goods rather than on an item-by-item basis. He also wants to bargain on tariffs directly with nations outside the European Common Market.

Congressional leaders think Kennedy has a chance of getting much of what he wants, but the fight may take as long as two years. Emergence of a unified European economy is bringing the U.S. trade issue to a head. Administration planners now see two super economies dominating the Free World in the years ahead. They believe that cooperation rather than cut-throat competition is the way to deal with the European Common Market.

CONGRESSIONAL sources report an increasing volume of Soviet Bloc purchases of electronic equipment from Free World sources. In the past 18 months, Russia has bought computers, television equipment, automation control gear for a sugar refinery, control instruments for a chemical plant and precision instruments. Poland has bought a complete stereo recording studio; Rumania, instrumentation and control equipment for an oil refinery; East Germany, television cameras; Hungary, a complete tv broadcasting unit. Major sources: Great Britain, West Germany, Italy, France and Japan.

LOOK FOR a big boost in defense spending for basic research next year, particularly in the physical sciences. This year's expenditures will total $148 million, up $13 million from fiscal year 1961. Harold Brown, director of defense research engineering, argues that another such increase might not buy more research because of increased costs.

Meantime, the Defense Dept. has issued a new policy directive on basic research, aimed at easing the lot of contractors. The new policy stresses the need for long-term funding and liberalized treatment of independent basic research expenses as allowable costs on certain contracts.

CONTROVERSY over private ownership of a communications satellite system has flared again. Charges that international communications companies would gain control of the system were renewed recently by domestic companies, sparked mainly by General Telephone and Electronics. The present plan was proposed to FCC by a committee composed mainly of international communications operators.

The issue was aired again this month before the Senate Small Business Subcommittee on Monopoly, headed by Sen. Russell B. Long (D-La.). Lee Loevinger, the Justice Department's antitrust chief, told the subcommittee that his department did not favor the plan either. The White House plans to put forth its own ownership plan to Congress early next year. Quite likely, it will include partial public ownership of the system.

Power 250 different klystrons with this new, high performance, ultra-dependable (hp) 716A Power Supply

Not only does this new (hp) instrument give you unique versatility for powering 250 different types of klystrons . . . but its unusually low ripple and high regulation mean almost total absence of FM and AM from high-performance klystrons.

The 716A has a high resolution reflector voltage control that eliminates the possibility of misadjustment. Reflector voltage may be set to within ±½% on the direct-reading, 3-foot voltage scale. Similarly, beam voltage may be set to within ±2%. Other features include a sawtooth supply for FM, a square wave supply for on-off operation, and a 6.3 volt regulated dc klystron filament supply for maximum tube stability.

The (hp) 716A is designed as the most useful, most valuable general purpose klystron supply yet offered. Ask your (hp) representative for a demonstration now.

SPECIFICATIONS

REFLECTOR SUPPLY:

Voltage:	0 to 800 volts neg. with respect to beam supply
Voltage Accuracy:	± 0.5% of dial reading
Current:	High impedance output
Ripple:	Less than 500 microvolts
Line Regulation:	Better than 0.05%

BEAM SUPPLY:

Voltage:	250 to 800 volts neg. with respect to ground
Voltage Accuracy:	± 2% of dial reading
Current:	0 to 100 ma
Ripple:	Less than 1 mv
Line Regulation:	Better than 0.1%
Load Regulation:	Better than 0.05%

REGULATED DC FILAMENT SUPPLY:

Voltage:	6.3 volts dc, adjustable internally, isolated from ground
Current:	0 to 2.0 amperes
Ripple:	Less than 15 mv
Line Regulation:	Better than 1%

INTERNAL SQUARE WAVE MODULATION:

Frequency:	400 cps to 2.5 KC
Amplitude:	10 to 200 volts, peak-to-peak, positive excursion clamped to reflector voltage
Rise Time:	< 5 microseconds
Frequency Stability:	0.1% short term

INTERNAL SAWTOOTH MODULATION:

Frequency:	60 cps
Amplitude:	0 to 200 volts peak-to-peak, ac coupled to reflector

EXTERNAL MODULATION:

Maximum Input:	200 volts peak-to-peak
Input Impedance:	500 K, 100 pf, nominal

EXTERNAL SYNCHRONIZATION OF INTERNAL SQUARE WAVE:

Input Voltage:	2 volts peak
Input Impedance:	500 K nominal

SCOPE SYNC:

When using internal square wave modulation:	Output impedance, 50 ohms; voltage, 10 volts, peak-to-peak, for scope sync
When using internal sawtooth modulation:	Output impedance, 50 K; voltage, 2 volts, peak-to-peak, for scope sweep

GENERAL:

Meter:	0 to 100 ma meter monitors beam current
Power:	115/230 volts ± 10%, 50/60 cps, approx. 200/350 watts depending on line voltage and load
Weight:	Net 45 lbs.
Dimensions:	16¾" wide, 7" high, 18⅜" deep overall (cabinet), hardware furnished converts cabinet to 7" x 19" for rack mounting
Price:	$675.00

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UNEQUALLED RF POWER AMPLIFIERS!

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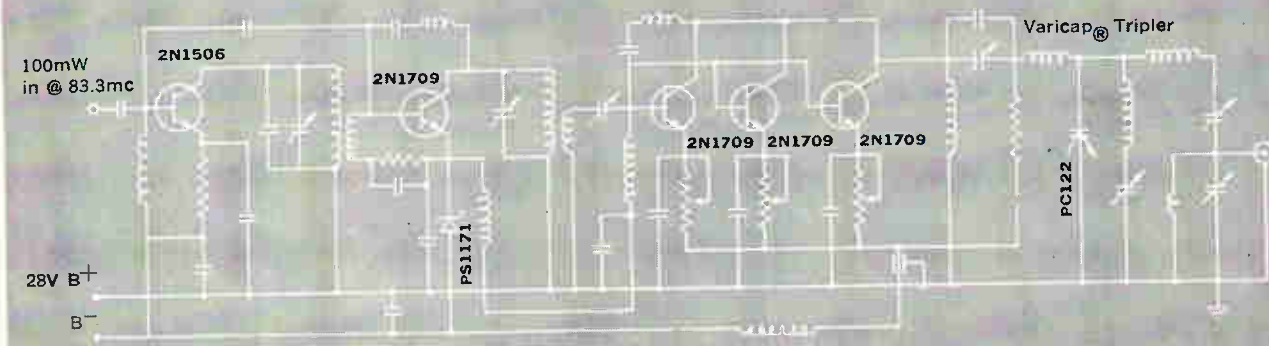
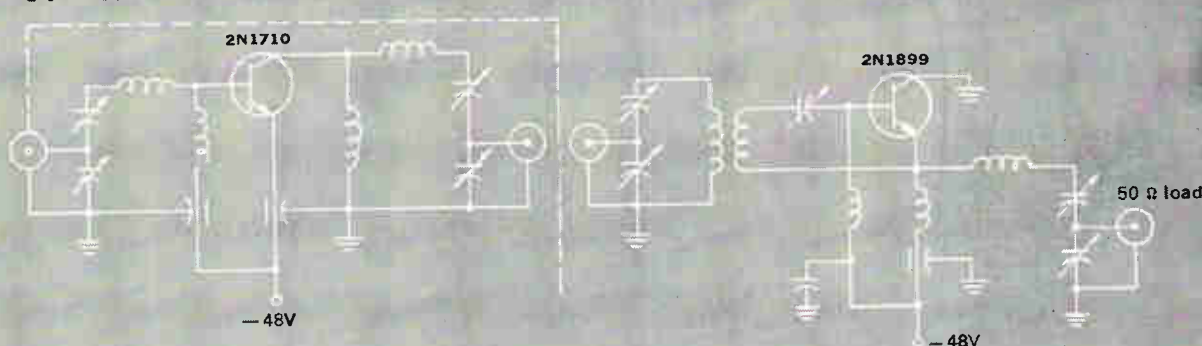


The diagram above shows a straight forward approach to obtain eight watts output at 250mc with 19db power gain and 30% over all efficiency. The popular 2N1505 and 2N1709 transistors are used in conjunction with the readily available and lower cost PC122 Varicap® frequency multiplier.

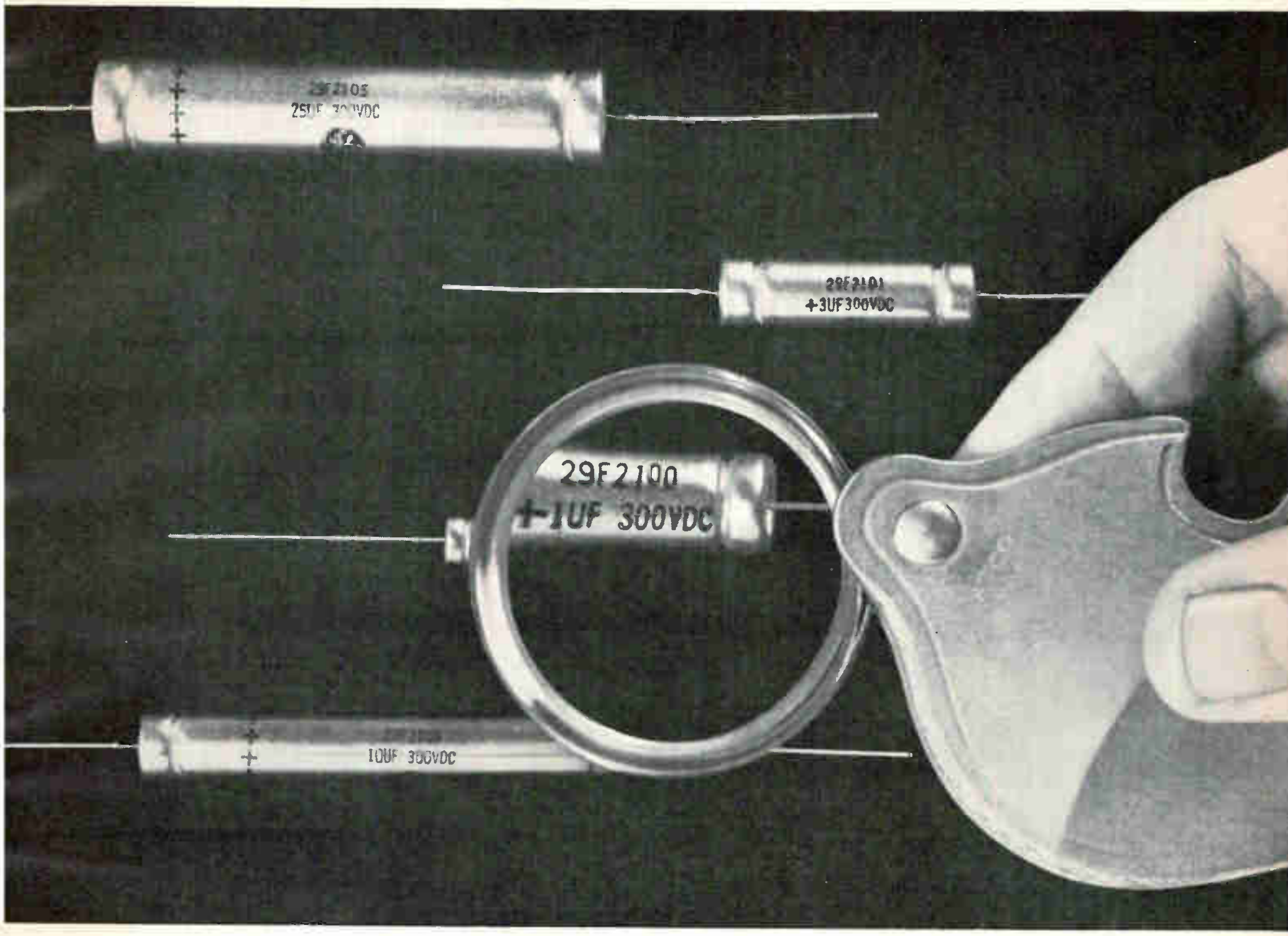
® Varicap is the registered trademark of Pacific Semiconductors, Inc.

50 WATT OUTPUT 30mc POWER AMPLIFIER



Fifty watts output at 30mc is obtained in the above circuit. Power gain is 17db, efficiency 50%. PSI Triple Diffused Planar Transistors 2N1710 and 2N1899 in this application make possible all-transistorized Class C Amplifiers of substantial power. Component values available on request.

ELECTROLYTIC CAPACITORS—Reliability is our first ingredient



The "case" for 300-volt Tantalytic* capacitors

The best capacitor case for 300-volt operation is General Electric's High Voltage Tantalytic* Capacitor. Its single-cell construction is the smallest and lightest for its rating. It weighs 0.1 ounce and measures only 0.875 inch in length.

Performance of this G-E unit distinguishes it as quickly as its size. Capacitance stays within 10% of original value even after 2000 hours testing at rated voltage and temperature. Impedance is lower at −55C than that of any other high-voltage tantalum capacitor.

These same features characterize the full line of ratings from 200V (.15 uf) to 300V (25 uf). Polar or non-polar designs are available from stock for 85C and 125C applications.

Data on G-E High Voltage Tantalytic Capacitors is found in Bulletin GEA-7065. Ask your G-E Sales Engineer for a copy today. Or write to General Electric Co., Schenectady, N. Y. *Capacitor Department, Irmo, South Carolina.* 430-02

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General Electric also offers these reliable Tantalytic capacitors

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125C KSR* TANTALYTIC CAPACITORS
Bulletin GEA-6766

"A CASE" TANTALYTIC CAPACITORS
Bulletin GEA-7226

125C CYLINDRICAL TANTALYTIC CAPACITORS
Bulletin GEA-7085

F-M Stereo Sales Rise

By ROY J. BRUUN,
Assistant Editor

CHECK OF BROADCASTERS, manufacturers and distributors shows heavy consumer demand for f-m stereo. The supply is barely keeping up.

According to NAB only Pittsburgh and Washington of the top 10 markets (8th and 10th) remain unserved with f-m stereo. Station WHFS is now under construction in Bethesda, near Washington.

Manager of WDHA, D. R. Bolgiano, says it has been serving the Metropolitan New York Area 18½ hours daily since Sept. 7. Many hi-fi manufacturers, he says, are providing advertising support. WSPA stereocasts 14 hours each weekday, 10 hours on Saturday and 11 hours on Sunday, according to station manager R. Hoyle.

WQXR presents 20½ hours of stereo music weekly. This is largely concentrated weekdays at mid-day and evenings, and includes 5½ hours on Saturday and 2½ hours on Sunday. Local distributors agree with Walter Neiman, station programming manager, that this schedule fits in nicely with their store demonstration efforts.

KPEN, stereocasting since August 10, says the station's time is sold out through February 1, with the San Francisco area "absorbing all the stereo equipment which can be received there."

STATIONS STEREOCASTING

Now	*22*
By end of 1961	*50*
By end of 1962	*123*
At some future time	*185*
No plans for f-m stereo	*140*
Using a-m/f-m stereo, no plans for f-m stereo	*24*
Range of planned weekly f-m stereo hours	*2-130*

F-m stereo facilities are not concentrated in any one geographical area. National Association of Broadcasters reports recent f-m stereo broadcasting installations have been made in St. Louis (KCFM), Houston (KGHM), Detroit (WOOD), Westbury, N. Y. (WTFM), Boston (WCRB), and Toronto, Canada (CFRB).

This is in addition to earlier facilities at New York City (WQXR), Dover, N. J. (WDHA), Garden City, N. Y. (WLIR), Los Angeles (KFMU, KMLA), Philadelphia-Wilmington (WFLN, WJBR), Detroit (WDTM), Boston, (WUPY), San Francisco (KPEN), Houston (KODA), Seattle (KLSN), Cincinnati-Dayton (WPFB), Dallas (KIXY), Albany-Schenectady, Troy (WGFM), Columbus, Ohio (WBNS), and Spartanburg, S. C. (WSPA).

Sets and Adapters

A check of New York City distributors indicates that their supply from manufacturers is not now keeping up with consumer demand. Some indicated a definite trend toward buying integrated f-m stereo receivers rather than adapters for monaural sets. One distributor was particularly enthusiastic with tape recorder sales prospects.

A General Electric spokesman feels that the sales trend will definitely be toward f-m stereo receivers rather than adapters for monaural sets and that the potential in 17 major markets is extremely optimistic. "Several thousand" adapter and receiver sales are reported by Pilot Radio. The company sees large markets in Chicago, San Francisco and New York City.

Olympic says nationwide sales of receivers are up to expectations with some models oversold. The company, feeling that consumers would not use adapters, has included f-m stereo provisions in all higher-priced equipments. Low priced lines are still monoraural.

RCA indicates that orders for the two-tiered RCA Victor designs have been so heavy that production since their introduction last June has more than doubled, with further increases probable. According to T. W. Lentz, sales planning and development manager, business is anticipated mainly in certain metropolitan areas. But, he says, "we have been receiving orders from all sections of the country, and from some areas that surprised us."

Zenith Radio, which is not manufacturing adapters, says their f-m stereo receivers are "oversold for the remainder of the year."

Henry Fogel, president of Granco Products (who pointed out in August, two months after FCC go-ahead, that industry sources expected stereo sales over the following 12 months to add \$50 to \$75 million to the \$300 million annual f-m market), included f-m stereo in both low and higher-priced receivers produced by his firm.

NEMA Seeks Members in New Electronics Fields

NATIONAL Electrical Manufacturers Association is moving aggressively into industrial electronics and research and development fields, says Gordon L. Nord, of Schauer Mfg. Corp., chairman of NEMA's industrial electronics and communications equipment division.

A static energy conversion section was established this year to include products in thermoelectrics, thermionics, fuel cells, batteries, photovoltaics, photochemicals and magnetohydrodynamics.

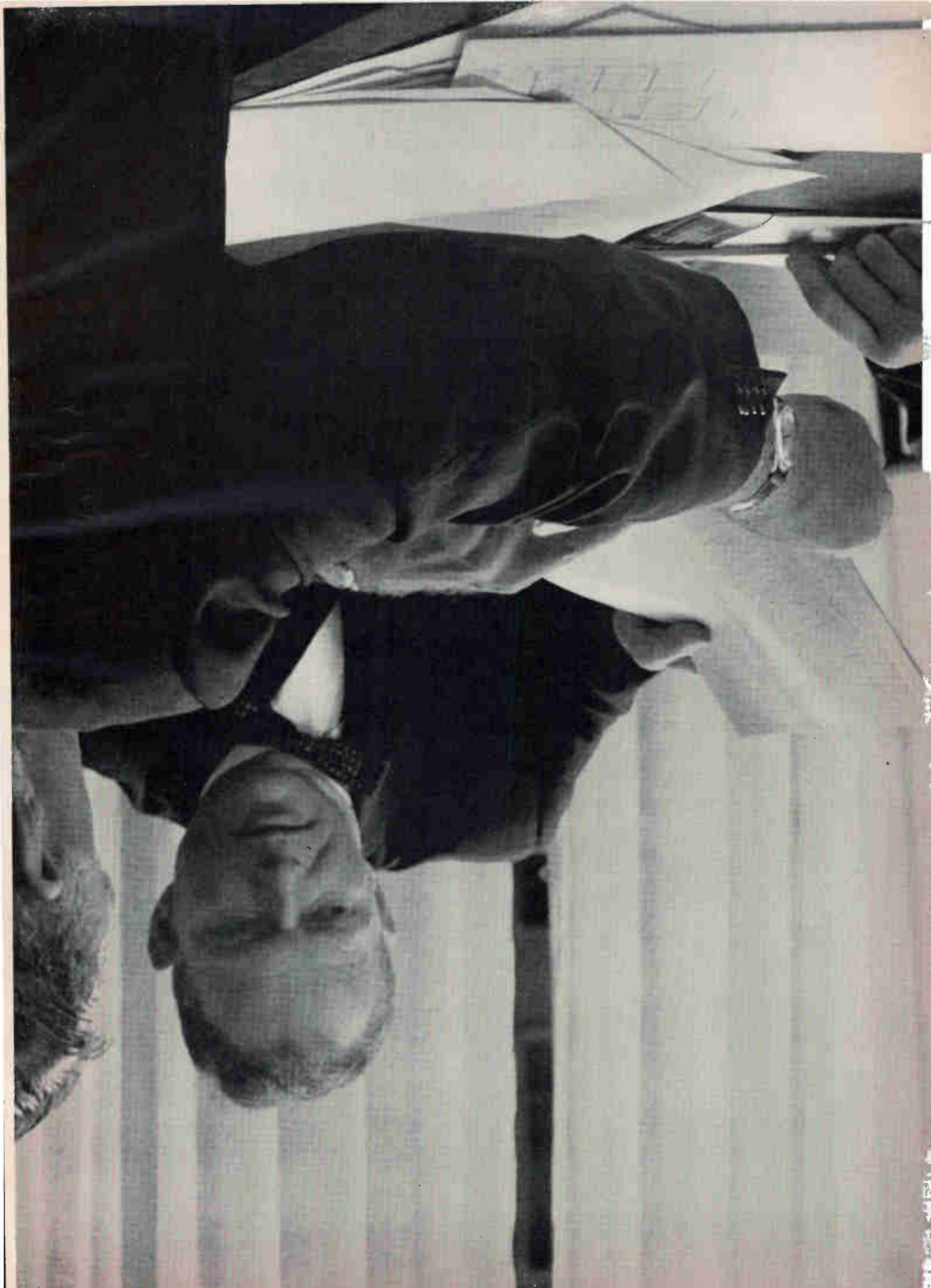
A section is being formed to cover terminal boards and connectors. Sections on induction and dielectric heating, medical electronics and ultrasonics are planned for the future.

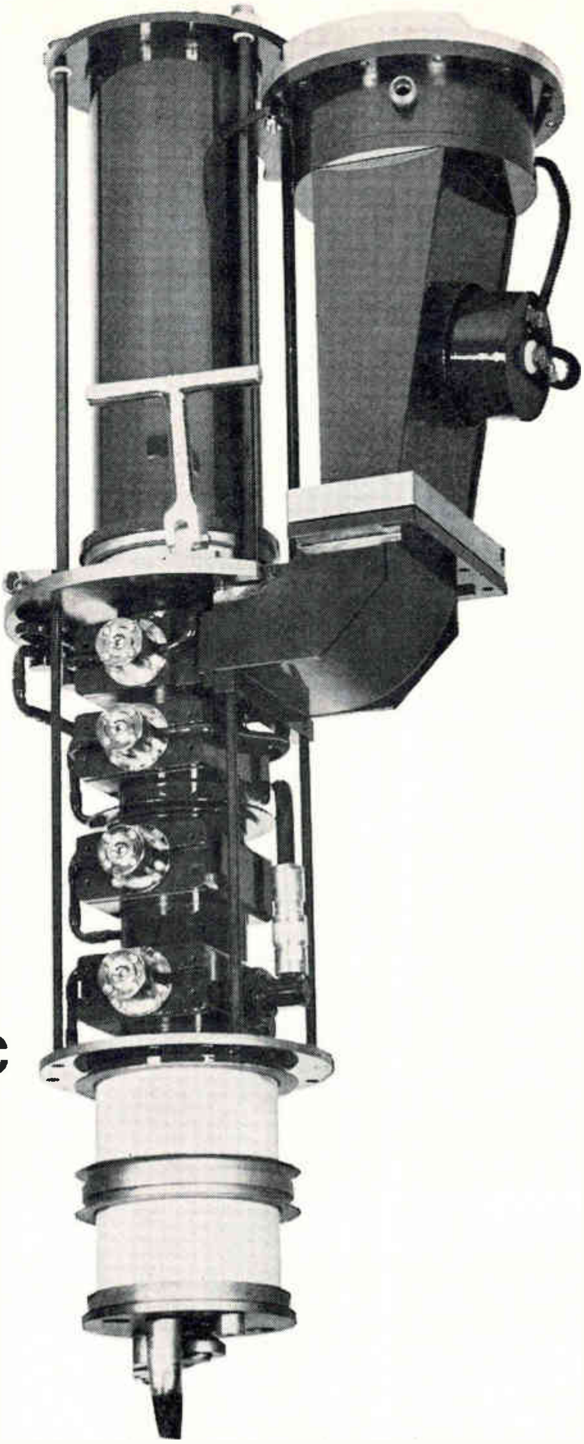
25 MOST ACTIVE STOCKS

WEEK ENDING NOV. 10, 1961

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	1,800	25 1/4	24 1/2	24 7/8
Burroughs Corp	1,460	38 3/8	35 5/8	37 1/2
Avco	1,388	25 1/2	23	25 1/2
Ling Temco Vought	1,170	25 7/8	23 1/8	23 1/2
Ampex	1,112	22 1/4	20 5/8	21 1/2
Magnavox	1,087	42 1/2	36 1/8	42 1/2
Sperry Rand	1,075	25 5/8	24 1/8	25 1/4
Westinghouse	915	41 1/8	39 1/8	41
Gen Elec	861	76 1/2	73	76 1/8
Elec Mus Ind	847	5 1/2	5	5 1/2
Nuclear Corp of Amer	732	4 1/8	3 5/8	4
Philco Corp	701	23 1/2	22 1/2	23 1/2
Univ Controls	670	9 7/8	9 1/4	9 1/2
Gen Dynamics	644	28 7/8	27 5/8	28 1/8
Hycon Mfg	600	4 7/8	3 3/4	4 3/8
Transitron	567	19 7/8	18 1/8	19
Martin Co	558	27 1/8	26 1/8	26 3/4
RCA	551	57 3/4	54 3/4	57 5/8
Gen Inst	513	32 1/2	28 1/8	32 1/2
Int'l Tel & Tel	498	55 7/8	52 5/8	55 1/4
Admiral	479	16	14 3/8	15 3/4
Gen Precision	428	60 3/8	54	60 1/4
Standard Kollsman	418	37	34 1/2	37
Texas Inst	411	116	107	113
Waltham Precision	387	3	2 3/4	2 3/4

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.





20KW CW AT 2KMC

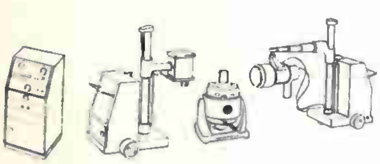
New Eimac 4KM70SJ klystron doubles CW power available at S-band. And offers all these outstanding features for scatter and space communications:

1. 20 kilowatts CW
2. Tunable – 1700-2400Mc
3. Minimum 3db bandwidth: 12Mc
4. Minimum wideband gain: 40db
5. Meets AN/FRC-56(v) specifications
6. Low heater power – no bombarder
7. One fixed magnet supply
8. High efficiency at both 10 and 20 KW
9. Built-in titanium vacuum pump
10. Fixed input and output coupling
11. Four integral cavities
12. Modulating anode

Write now for complete data and delivery schedules:
High Power Microwave Marketing, Eitel-McCullough, Inc., San Carlos, California.

environmental testing come from MB

New MB-Zenith 150 KV pulsed X-ray system takes motion pictures of high speed phenomena



A pioneer and leader in the field of electrodynamic vibration systems, MB continually strives to improve the performance and reliability of vibration, shock and fatigue testing. The important advances in environmental testing come from MB.

MB Electronics has representatives in principal cities throughout the world.

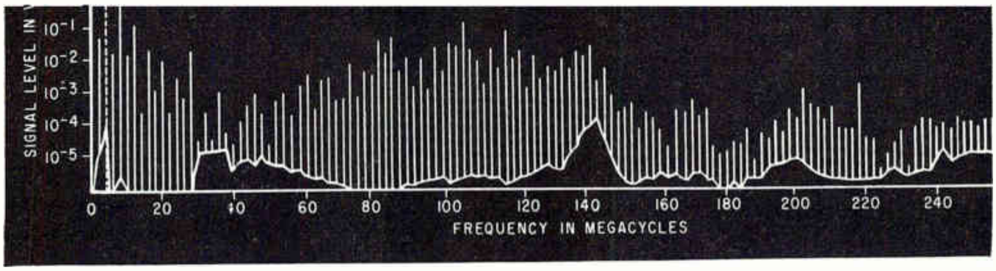
Now test engineers can probe effectively into the causes of vibration and shock failures, or observe dynamic systems, detonation effects and other high speed phenomena occurring within a sealed environment.

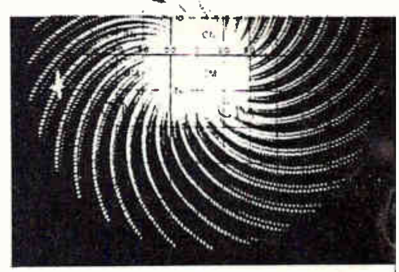
The pulsed X-ray system developed by Zenith Radio Research Corp. and marketed by MB Electronics provides an effective means of obtaining X-ray motion pictures of these rapidly moving sealed parts. Typical of the capabilities of the system is the above reproduction of a high speed motion picture of an hermetically sealed relay in operation while being vibrated.

The image obtained with the pulsed X-ray system is more than 2000 times brighter than that obtained with an X-ray fluorescent screen. It is suitable for direct viewing, closed circuit TV or motion picture camera. Adequate film density is obtained through 2″ of aluminum at a distance of 3 feet from the tube.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1060 State Street, New Haven 11, Conn.





Graph shows how a typical 4-Mc transmitter emits spurious radiation over a wide range of frequencies. The "pinwheel" is an rfi-plagued radar scope. Finding a target aircraft on this display would be almost impossible

Electromagnetic Compatibility Analysis Center Ready to Start Battle with RFI

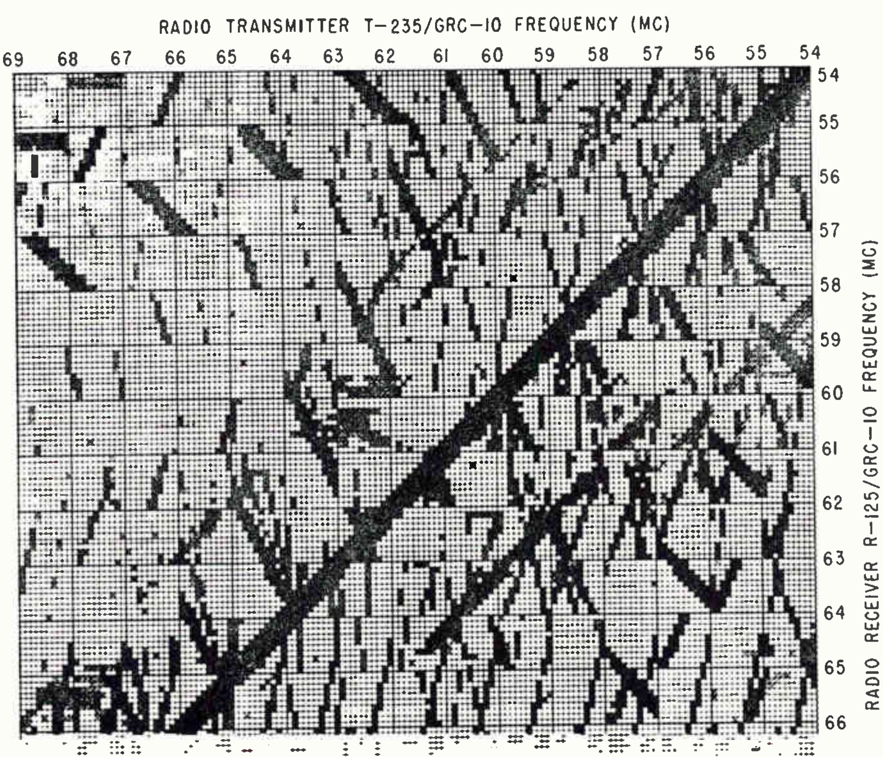
Radio interference Conference hears DOD plans to push solutions to interference problems. Ultimate step is control over equipment design

By CLETUS M. WILEY,
Midwest Editor

CHICAGO—Department of Defense's new Electromagnetic Compatibility Analysis Center (ECAC) at Annapolis—charged with reducing r-f interference among military electronics equipments—will begin paying off next month with solutions aimed at operational problems.

Officials in charge of ECAC (ELECTRONICS, p 24, June 2, 1961) gave a status report this month at the Seventh Conference on Radio Interference Reduction and Electronic Compatibility. The meeting was at Armour Research Foundation, which is also ECAC technical contractor.

Blackened areas on mutual interference chart indicate frequencies at which the transmitter will interfere with the receiver



Brig. Gen. John A. McDavid, director of communications-electronics, Joint Chiefs of Staff, said the center's first efforts will be to alleviate existing problems. Systems will be modified to improve compatibility and operational plans and techniques will be reviewed and revised.

As capability for rfi identification and control grows, emphasis will shift to ensuring compatibility while equipment is still in R&D.

McDavid noted that the importance of coping with rfi and signal degradation—"the gremlin of all gremlins"—has assumed "spectacular proportions". Rapid increase in the number of r-f emitters in military use is multiplying problems. For example, a field army now has 60,000 emitters, four times World War II.

The center is attacking the problem on component, equipment, system, R&D and operational use levels. Col. C. C. Woolwine, director, said it would give Army, Navy and Air Force a common ground on which to combat rfi and coordinate R&D in this field.

As the center's data base grows, its findings will increasingly affect the electronics industry. ECAC is to provide consulting services to the military and to designers of militrary electronics equipment.

S. I. Cohn, technical operations director, outlined programs to collect and analyze data: an updated Military Spectrum Signature Plan, computer analyses of cross-interferences, mathematical models of rfi-loaded areas, problem solving in the field and other activities.

Signatures being collected show characteristic output or response, through the r-f spectrum, of all military emitters and receivers. Under considerations are revisions to the plan which would bring into it guided missiles, homing systems, unconventional radar and communications, and other equipment.

Although the center is not yet completed or fully-staffed, it is well into its technical program. Already under analysis are interference problems involving radars and radar-communications sites. Mathematical models are being built for three military bases, including some installations at Fort Huachuca. Validation of these models is expected by mid-1962.

Another speaker, L. F. Babcock, of Bell Aerosystems, described activities at Fort Huachuca (ELECTRONICS, p 38, Nov. 1, 1960). With computer techniques and 400 transmitters, one system is simulating the 12,000 to 15,000 emitters in an Army corps. Environments are created, analysed and trouble-shooted at a rate of about 1,000 a day. The system may eventually be expanded so that radiators of Navy, Air Force, ally and enemy types are mixed with the Army's, to realistically simulate tactical situations.

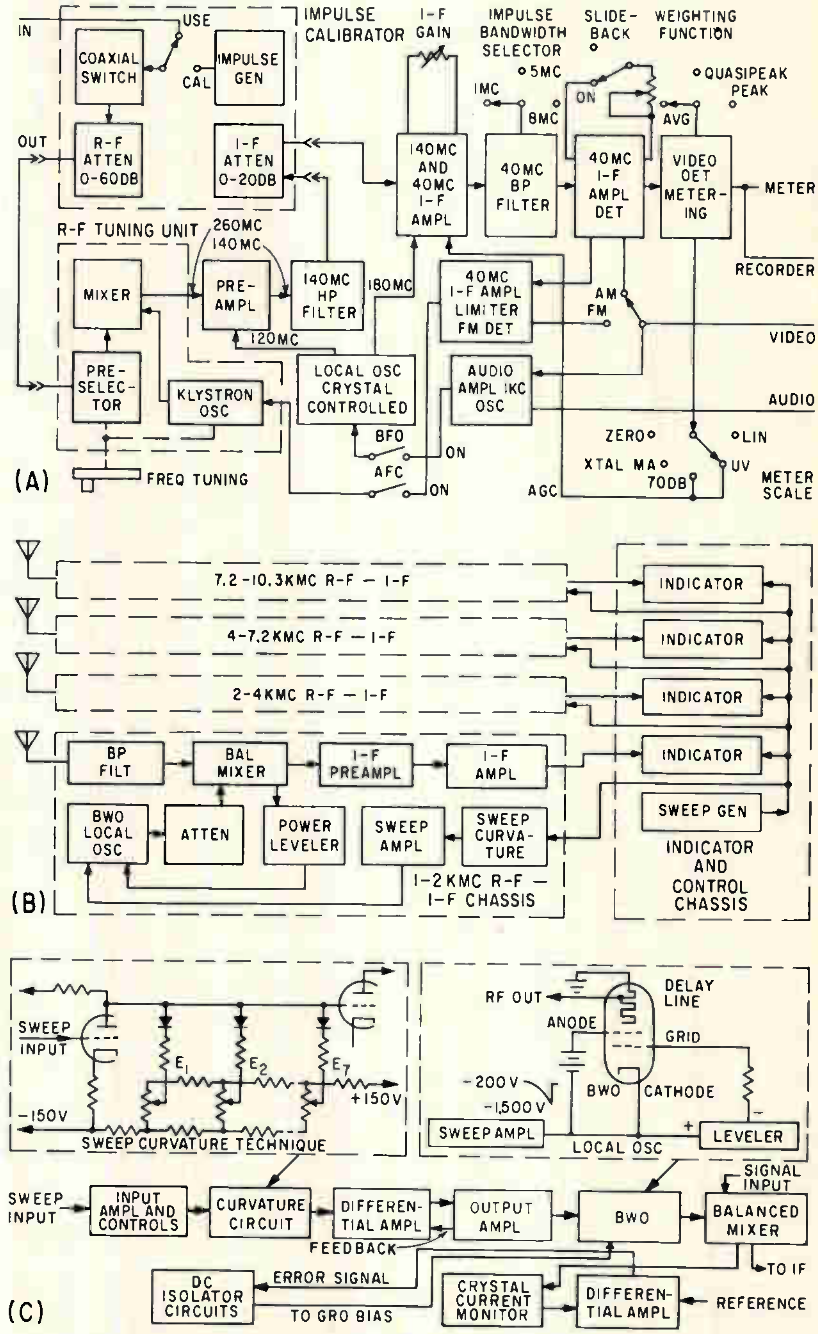
Among new equipments reported was an almost-all-transistor r-f field intensity receiver. It uses only five tubes: klystron oscillator, vtvm, preamplifier and high input impedance peaker. G. Lopez and M. Engelson, of Polarad Electronics, detailed how transistors are used to improve design of this type of equipment as well as to reduce size and weight.

The receiver, a triple-conversion, superheterodyne type, is outlined in Fig. A. It is compatible with existing equipment, the authors said, and measures broadband interference in four ranges between 1 Gc and 10 Gc.

Another 1 Gc to 10 Gc system, a panoramic receiver for rfi monitoring, was described by R. Powers, of Rome Air Development Center, R. H. Sugerman and K. E. Walker, of American Electronic Laboratories. Fig. B is a simplified block diagram.

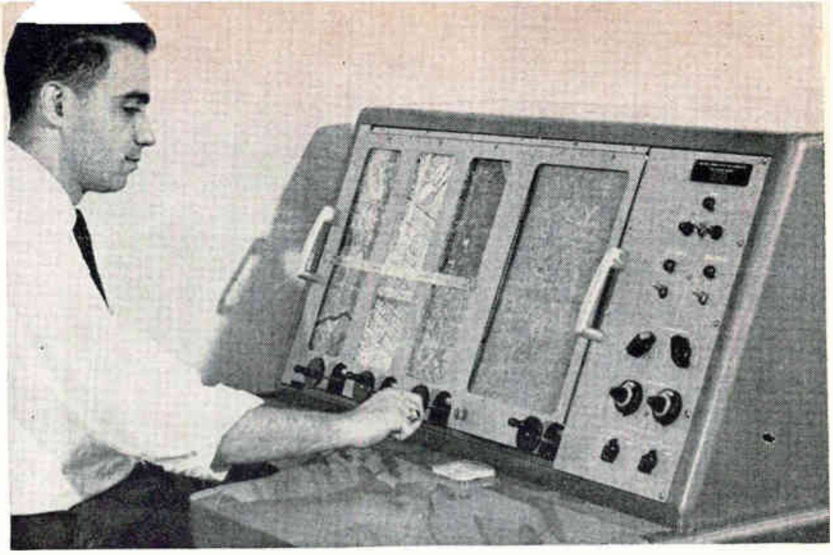
The entire frequency range is covered continuously and simultaneously by sweeping through the four bands. The receiver (AN/GRR-9) quickly locates signal areas requiring detailed analysis. The curvature and leveler circuits (Fig. C) overcome nonlinearity and variations in power output of the bwo.

Coherent memory filter, using a recirculating delay line heterodyne feedback loop to approximate a signal spectrum in real time, was discussed by J. Capon, of Federal Scientific. The device provides continuous spectral coverage, from 0 to 8 Kc, observing rapid changes in input spectrum from one processing period to the next. Integration time is adjustable, so variable resolution analysis of nonstationary spectra is possible. The equivalent of a filter bank with approximately 100 filters can be synthesized.



Multiband receivers designed by Polarad (A) and American Electronics Labs (B) for 1 Gc to 10 Gc range. AEL receiver uses curvature and leveler circuits (C) to assure accurate display on crt indicators

Console developed for Air Force correlates radar, infrared and photographic data. Development may lead to airborne systems which synergistically provide new target information to pilots



System Correlates Reconnaissance Data

By MICHAEL F. WOLFF,
Senior Associate Editor

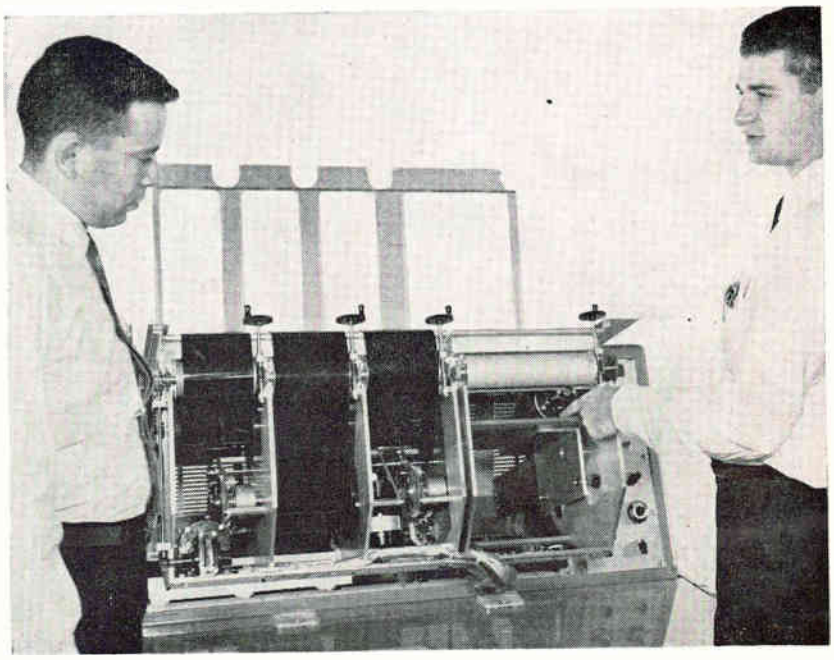
AIRBORNE SYSTEMS that can interpret reconnaissance data in real time would, by eliminating ground processing, allow reconnaissance aircraft to take immediate action against enemy targets.

A first step in development of such systems may be a multiple-sensor viewer and correlator for ground use, recently completed by Ford Instrument division of Sperry Rand. The console, based on a two-year study at Ford of in-flight sensor correlation, was to be delivered last week to the Air Force Aeronautical Systems Division.

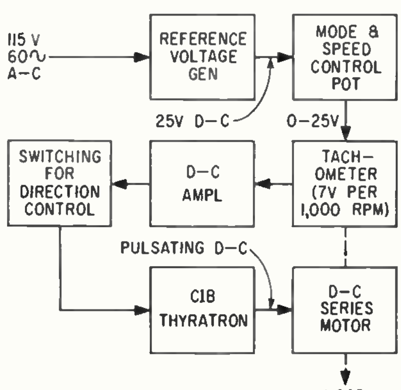
A key advantage of correlated displays is their synergism. That is, target information can be obtained from combined presentations that would not be found by viewing the displays individually. Air Force hopes this feature can be made characteristic of future reconnaissance systems.

The display console permits correlated viewing of up to four reconnaissance presentations on the ground. Left-hand display area consists of three channels with a common film drive for side-by-side presentation of, typically, radar, infrared and visual data.

Ganged crosshairs indicate correspondence between points on adjacent displays. A supplementary channel on the right is used for data that might not always be correlated, such as still photographs. Film speed is varied over a range of 0.03 to 3 inches a second to simulate different flight conditions.



Top photo shows engineer aligning channels of multiple sensor viewer and correlator. At bottom, mechanism is in loading position to show film drives



One of two servos providing film drive speed control over a 100:1 range

Film capacity of the three left-hand channels is 300 ft of 5-inch (or smaller) film. Capacity of the other channel is 400 ft of 9.5-inch (or smaller) film. The film can run from top to bottom or bottom to top through servo-controlled direct roller drive. Film tension is provided by hysteresis clutches. Each channel can be adjusted manually to correct any accumulated creep.

A typical photointerpretation experiment that might be conducted with the console would involve the synchronous presentation of side-looking radar, infrared and aerial camera data. Observers will be scored on their ability to detect targets under simulated flight conditions. Knowledge gained from these experiments is expected to determine optimum display conditions for an in-flight synergistic system.

Such a system might eventually be tied in with a learning machine so that targets could be recognized automatically.

However, the system most plausible for the next several years would use the learning machine to select several key targets. The human observer would make the final selection.

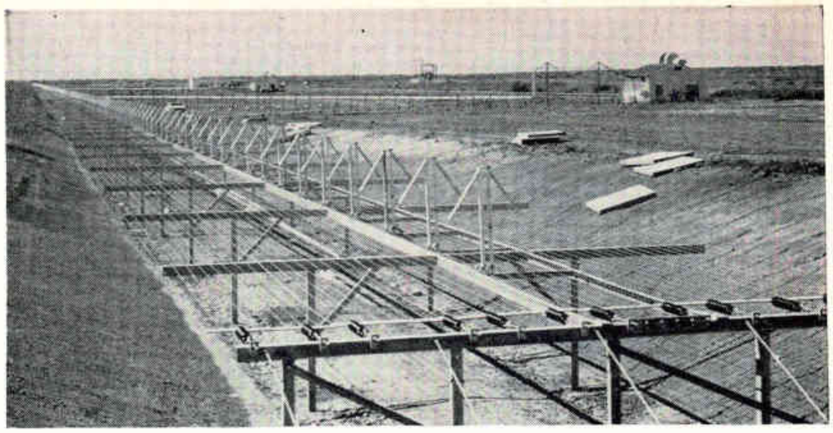
The console delivered to the Air Force is a laboratory model. But its designers claim it can be modified to meet other military requirements. For example, it could be mounted in a trailer for Army personnel to view drone pictures quickly and decide on battlefield movements accordingly.

Scatter Radar to Probe Ionosphere and Space

NATIONAL BUREAU of Standards and the Institutio Geofiscio de Huancayo are installing a six-megawatt pulse transmitter with a 22-acre antenna near Lima, Peru. The antenna is made of 9,216 crossed dipoles mounted six feet above a reflecting ground screen. Completion date is next month.

Scatter radar techniques will be used to determine electron densities at heights of 100-3,000 Km, kinetic temperature of ions at 200-3,000 Km, percentage composition of ionic components at 200-700 Km and 1,200-1,800 Km, and the intensity of the earth's magnetic field.

The system will also be used for limited observations of radar echoes from the sun's corona and solar gas clouds, to study small irregularities in the outer atmosphere, to study the ionosphere's D-region, to calibrate satellite instrumentation and to search for radio stars one magnitude weaker than those observed to date.



Mile-long antenna installed by Antenna Systems Inc., near Olney, Texas, as part of Navy's Spasur, the satellite detection fence

Air Force Is Planning New, Better Space Track System

By THOMAS MAGUIRE,
New England Editor

AIR FORCE is shaping plans for a second-generation satellite detection and tracking network. First-generation net is pretty much a patchwork of systems not designed for space surveillance.

Proposals and R&D studies for the new network cover a wide range: giant radar systems for surveillance at or near the equator; stepped-up development of high-power tubes and phased-array techniques; special computers for preliminary data processing at tracking sites; extensive exploration of electro-optics, including image orthicons and TV techniques; more sophisticated data reduction for real-time evaluation of radar and optical outputs; and automated communications.

Researchers believe it may be years—or even decades—before optical masers can be applied to space surveillance, but present-day electro-optical methods are being explored, along with advanced radar.

Focal point for the program is the Space Track R&D facility at Hanscom Field, Bedford, Mass. Since July 1 of this year, operational surveillance-tracking of satellites has been the job of Spadats (Space Detection and Tracking System) at Colorado Springs. The Space Track R&D facility gets the same inputs from tracking sites and functions as a backup for Spadats, but its job is essentially to come up with new methods.

There are today about 115 objects in orbit, including rocket casings and other "junk." Air Force has the responsibility for knowing what's in orbit, where each object is, and where it's going to be. But tracking is not the major problem. It is detection—particularly of a potentially hostile satellite.

To strengthen detection capabilities, Space Track leaders have proposed to DOD the construction of equatorial coverage radar systems, since every satellite has to cross the equator twice every orbit. Estimated cost of electronics for such a system is $35 million. Surveillance radar would be either on the equator or look at it.

If and when project is approved by DOD, industry will be asked to come up with advanced radar concepts to meet increased needs in volume coverage, angular resolution, range and range rate data, and high tracking speed. Navy's Spasur, the satellite detection fence across the U. S., uses cw radar, but AF researchers at Space Track favor pulsing techniques for proposed equatorial coverage radar. Goal is determination of satellite's orbital elements with single pass.

Space Track researchers are also investigating optical surveillance systems. Though limited by the fact that the satellite must be in the night sky but still illuminated by the sun, optical systems can be effective at extremely long ranges which are beyond the practical capability of radar. Chief problem is in data processing: how to null out thousands of stars and pick up the lone satellite. Among techniques being developed is scanning of photographic plates used as memory devices.

Already underway is integration of the satellite surveillance net with other detection-tracking systems, notably Bmews. Spadats trackers would be able to take satellite information off the forward side of the Bmews system, after target discrimination by Bmews.

In the next-generation Space Track system, says Technical Director E. W. Wahl, special-purpose computers will permit data processing at the tracking sites. It will not be necessary to transmit to the Space Track center every radar hit. Six-second average values could be teletyped to the center.

At Spadats and also at the Space Track R&D facility, the Air Force has installed Philco 2000 computers.

The computer's 48-bit basic structure allows accuracy to 11 digits, making it suitable for celestial mechanics, which requires accuracy to at least nine digits.

Pin-Head Search Coil

Miniature search coil is used at Battelle Memorial Institute to measure eddy and induction currents in small and inaccessible parts, to pinpoint defects. Coil has 200 turns of wire on 0.0008-inch iron core

Information Centers Multiply

By WILLIAM E. BUSHOR, Senior Associate Editor

BOSTON—At least 144 new scientific information centers (SIC) have been started since 1940, with the greatest growth years around the time Sputnik was launched and the International Geophysical Year began. The earliest SIC opened in 1830. By 1940, there were 59.

Highlight of the recent annual convention of the American Documentation Institute held here was a critical survey of SIC development, function and utilization. The survey, given by G. S. Simpson, Jr., was based on a study made by Battelle Memorial Institute for the National Science Foundation.

Function of Centers

Primary purpose of an SIC is to prepare authoritative, timely, specialized reports on a subject. Centers differ from libraries in that they operate at the information frontiers. They obtain information from a wide variety of sources—frequently including classified or proprietary reports—and are able to analyze it.

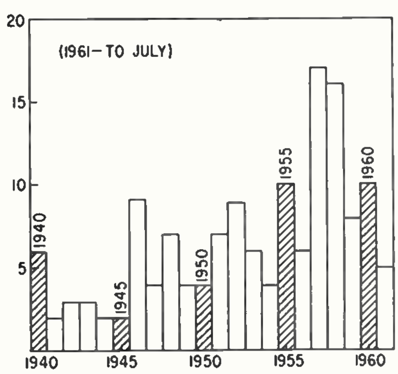
SIC interests include 24 subject areas. No SIC reported electronics within its first three areas of specialization. Most covered were physics (62), biological sciences (56) and chemistry (51), Simpson reported. Electrical engineering (18), closest to electronics, was 14th.

Despite the apparent overlapping of interests, there is little duplication of SIC services. Usually, each center specializes in a different aspect of the general field. (Note: for example, see the listing of materials information centers in ELECTRONICS BUYERS' GUIDE, p R39, July 20, 1961.)

Of some 6,000 people working in SICs, 2,085 are scientists and engineers and 381 are computer personnel. Many of the 740 people listed as information specialists are also scientists and engineers.

SIC managers say that the least of their critical problems is foreign translations. The obvious conclusion that there is adequate coverage may be incorrect. U. S. scientists may not be using this service, or publication controls in some countries, notably the USSR, may diminish the value of translations.

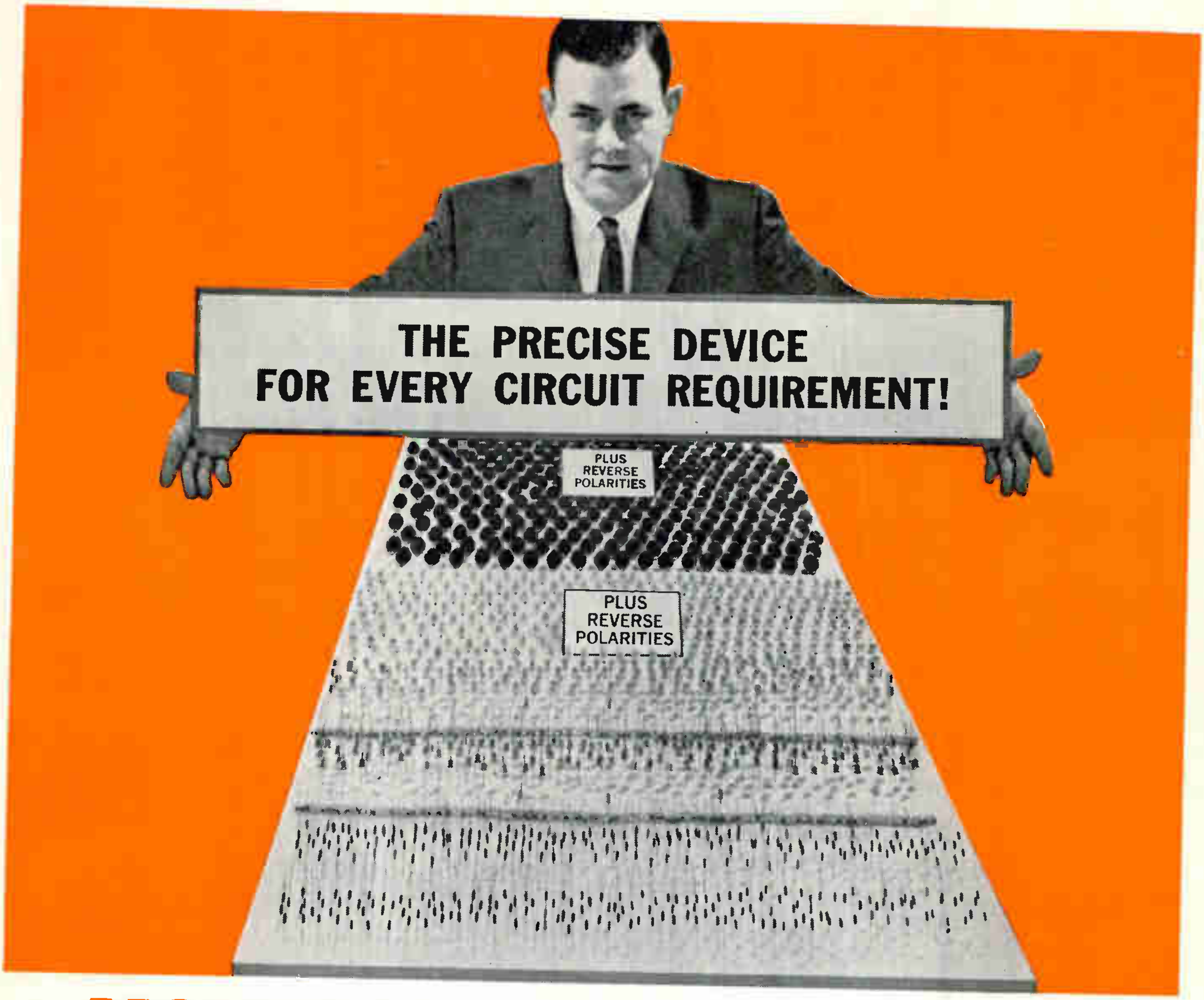
During a panel discussion of Simpson's paper, the lack of answers to a number of questions indicated need for further study of the SIC approach. Among moot points were: Will future SICs continue to operate independently? Is remote interrogation a future possibility? Is there a correlation between numbers and kinds of SICs and the amount and types of information generated? What is the status of specialized information groups (not included in Simpson's definition of an SIC) which prepare abstracts, literature searches and bibliographies?



New scientific information centers, year-by-year

Oxygen-Free Lubricant Extends Life of Gyros

AC SPARKPLUG says it has developed a method of removing all but 10 parts per billion of oxygen in gyro lubricants by a process akin to vacuum bakeout. Stopping oxidation, which causes varnish-like deposits in bearings, is reported to extend gyro life three or four times. Gyro is put in a high vacuum, vacuum chamber is filled with purified helium, then residual oxygen is removed by burning it out of the helium.



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MEETINGS AHEAD

VEHICULAR COMMUNICATIONS, PGVC of IRE: Madison Hotel, Minneapolis, Minnesota, Nov. 30-Dec. 1.

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

RELIABILITY AND QUALITY CONTROL, 8th National Symposium, PGRQC of IRE, AIEE, ASQC, EIA: Statler Hilton Hotel, Washington, D.C., Jan. 9-11, 1962.

MILITARY ELECTRONICS, 3rd Winter Convention PGMIL of IRE (L.A. Section); Ambassador Hotel, Los Angeles, Calif., Feb. 7-9, 1962.

SOLID STATE CIRCUITS, International Conference, PGCT of IRE, AIEE; Sheraton Hotel and U. of Penn., Philadelphia, Pa., Feb. 14-16, 1962.

APPLICATION OF SWITCHING THEORY TO SPACE TECHNOLOGY Symposium, USAF, Lockheed Missiles and Space; at Lockheed, Sunnyvale, California, Feb. 27-Mar. 1, 1962.

SCINTILLATION AND SEMICONDUCTOR COUNTER Symp. PGNS of IRE, AIEE AEC, NBS; Shoreham Hotel, Washington, D.C., Mar. 1-3, 1962.

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

SOUTHWEST IRE CONFERENCE AND SHOW; Rice Hotel, Houston, Texas, April 11-13, 1962.

JOINT COMPUTER CONFERENCE, PGEC of IRE, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3, 1962.

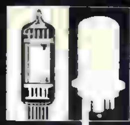
HUMAN FACTORS IN ELECTRONICS, 3rd National Symposium, PGHFE of IRE; Los Angeles, Calif., May 3-4, 1962.

ELECTRONIC COMPONENTS Conference, PGCP of IRE, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D.C., May 8-10, 1962.

NATIONAL AEROSPACE ELECTRONICS Conference, UGANE of IRE; Biltmore Hotel, Dayton, Ohio, May 14-16, 1962.

ADVANCE REPORT

MILITARY ELECTRONICS, *6th National Convention, PGME of IRE: Shoreham Hotel, Washington, D. C., June 25-27, 1962. Call for papers in the following suggested areas (not limited to these topics): current problems of space technology, space electronics, ranging and tracking, electronic propulsion, data handling systems, molecular electronics and systems, guidance and control, inertial systems reconnaissance systems, communication systems, operational analysis, reliability. The technical program will include both classified and unclassified sessions with the Air Research and Development Command sponsoring the classified sessions. Prospective authors are requested to furnish the following information to John J. Slattery, F 316, The Martin Company, Baltimore 3, Maryland not later than February 1, 1962: 750 word unclassified abstract, author's name and position, name and address of organization, three copies of biographical sketch.*



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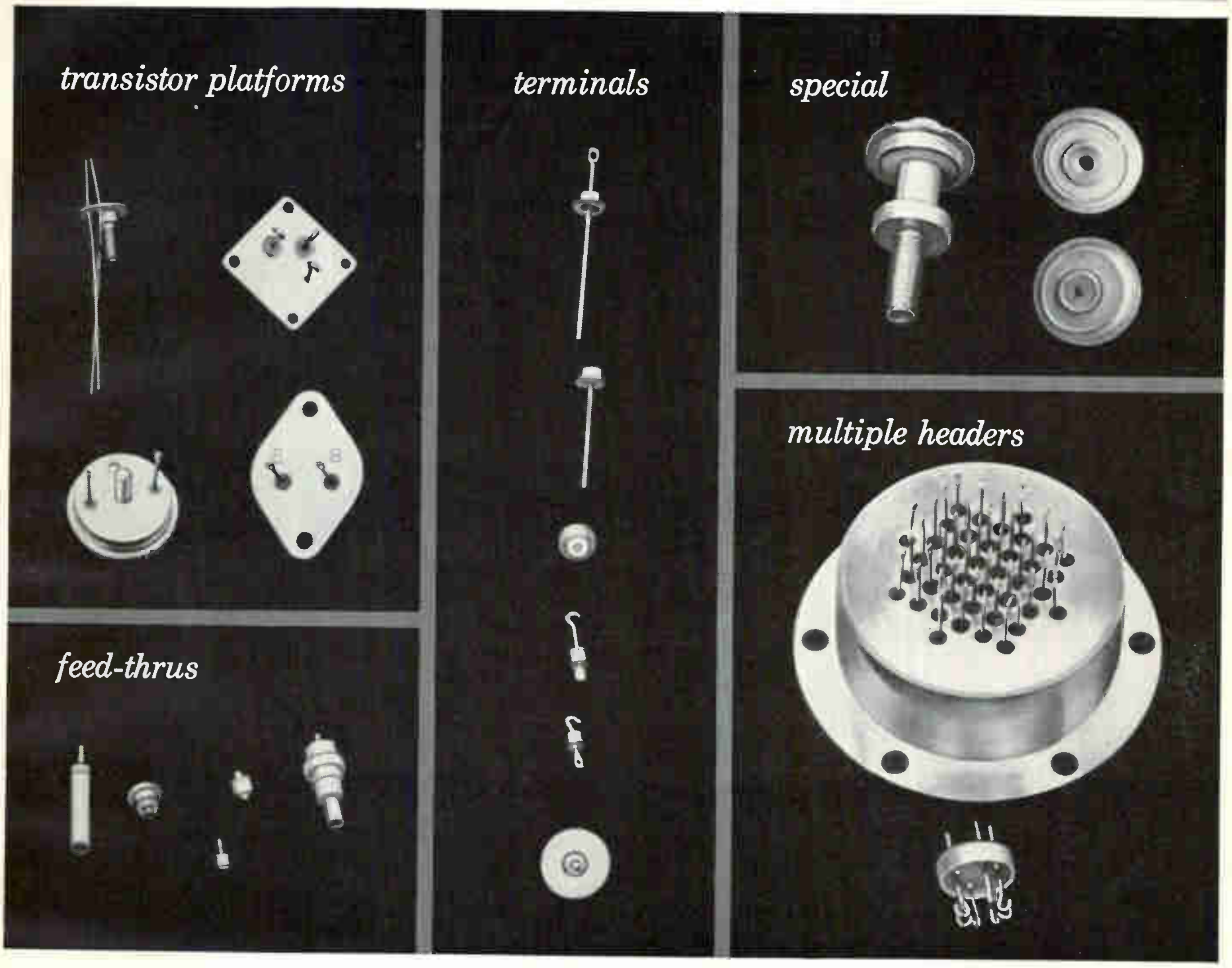

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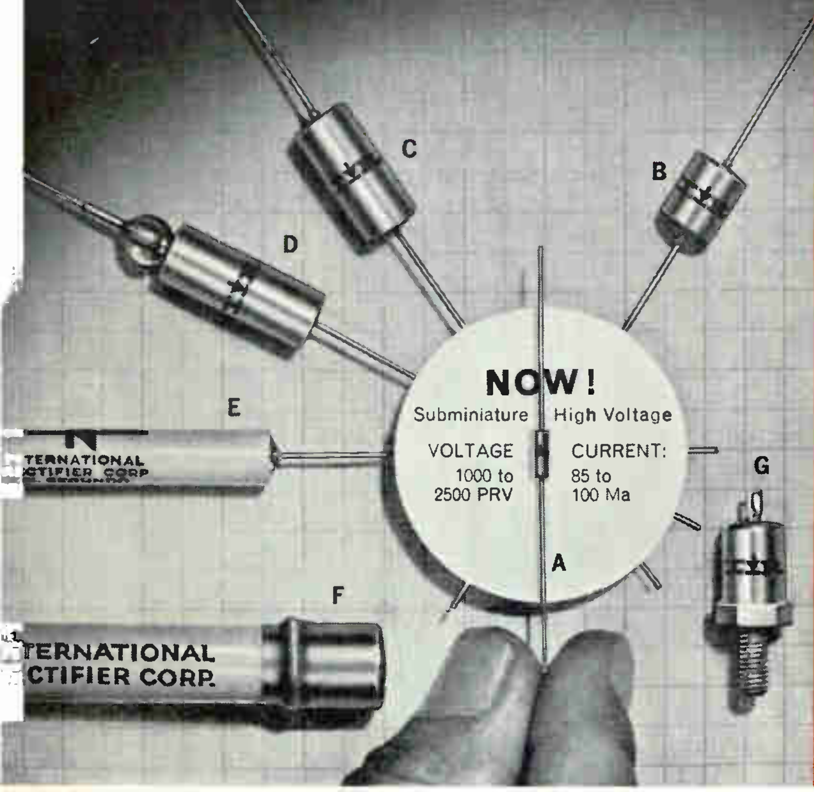

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TYPE NUMBERS	PEAK REVERSE VOLTAGE (VOLTS)	AVERAGE RECTIFIED FORWARD CURRENT (MA) @ 25°C	AVERAGE RECTIFIED FORWARD CURRENT (MA) @ 75°C	OPERATING TEMP. RANGE
CASE A: SUBMINIATURE DIFFUSED MULTI-CELL TRI-SEALED TYPES				
Q10X thru Q25X	1000 thru 2500	85 to 100	28 to 50	–20 to +130°C
CASE B. METAL CASE, HERMETICALLY SEALED				
1N5[illegible] thru 1N5[illegible]	[illegible]00 thru 1000	145	125	–55 to +150°C
CASE C METAL CASE, HERMETICALLY SEALED				
1N1406 thru 1N[illegible]	[illegible]00 thru 10[illegible]	115	100	–55 to +150°C
CASE D: METAL CASE, HERMETICALLY SEALED				
1N1409 thru 1N1413	1200 thru 2[illegible]00	115	100	–55 to +150°C
CASE E. CERAMIC CASE, HERMETICALLY SEALED. HIGH ALTITUDE TYPES				
1N2373 thru 1N2351	600 thru 10,000	75 to 250	40 to 150	–55 to +150°C
CASE E CERAMIC CASE, HERMETICALLY SEALED				
1N1730 thru 1N1733	1000 thru 3000	150 to 200	75 to 100	–65 to +125°C
CASE E CERAMIC CASE, HERMETICALLY SEALED				
USA1N1731 USA1N1733 USA1N1734	1500 3000 5000	100 to 200	50 to 100	–65 to +125°C
CASE F CERAMIC CASE, HERMETICALLY SEALED				
1N1133 thru 1N1149	1500 thru 1[illegible],000	50 to 115	45 to 100	–65 to +150°C
CASE F. CERAMIC CASE, HERMETICALLY SEALED HIGH CURRENT TYPES				
1N1745 thru 1N1762	1500 thru 1[illegible],000	290 to 505	250 to 440	–55 to +150°C
CASE G METAL CASE, STUD TYPE, FOR AIRBORNE AND MISSILE EQUIPMENT				
1N1130 1N1131	1500 1500	[illegible] [illegible]	275 275	–65° to +150°C

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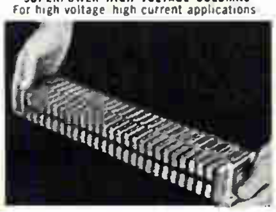

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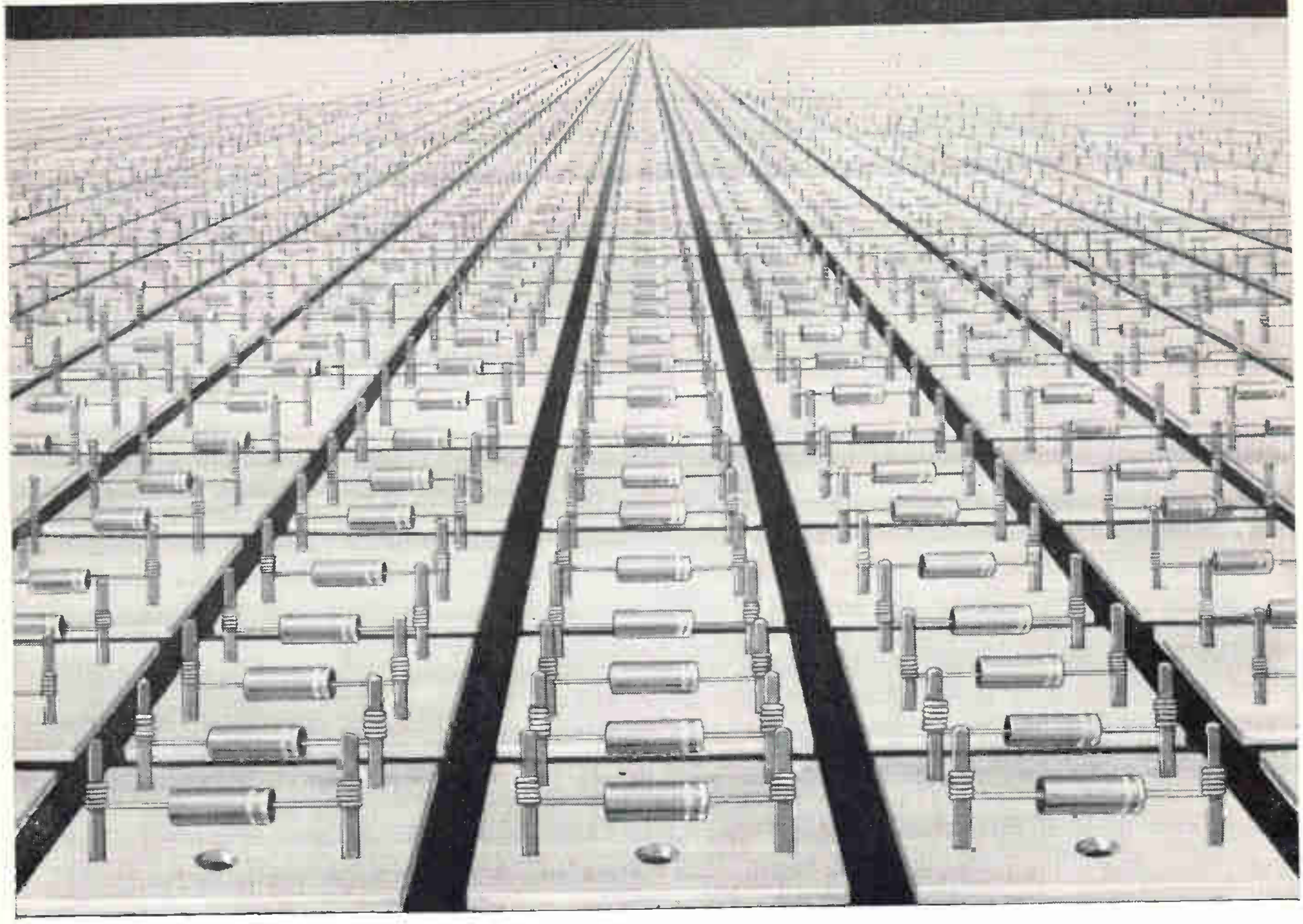

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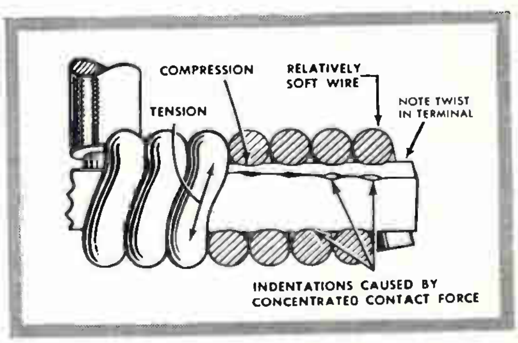

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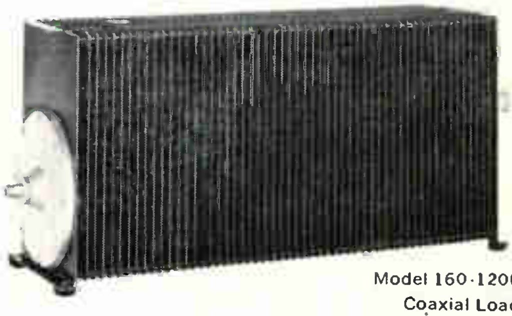

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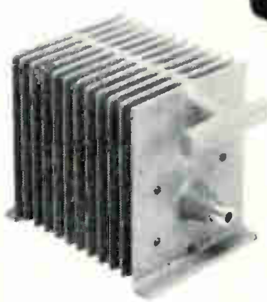

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Model	Full Power at 40° C, still air	VSWR Less Than	Frequency Range	Price
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160-20	20 watts	1.10 1.15 1.50	DC-1 gc DC-4 gc DC-6 gc	$ 40.00
160-100	100 watts	1.10 1.20 1.50	DC-500 mc DC-4 gc DC-5 gc	$140.00
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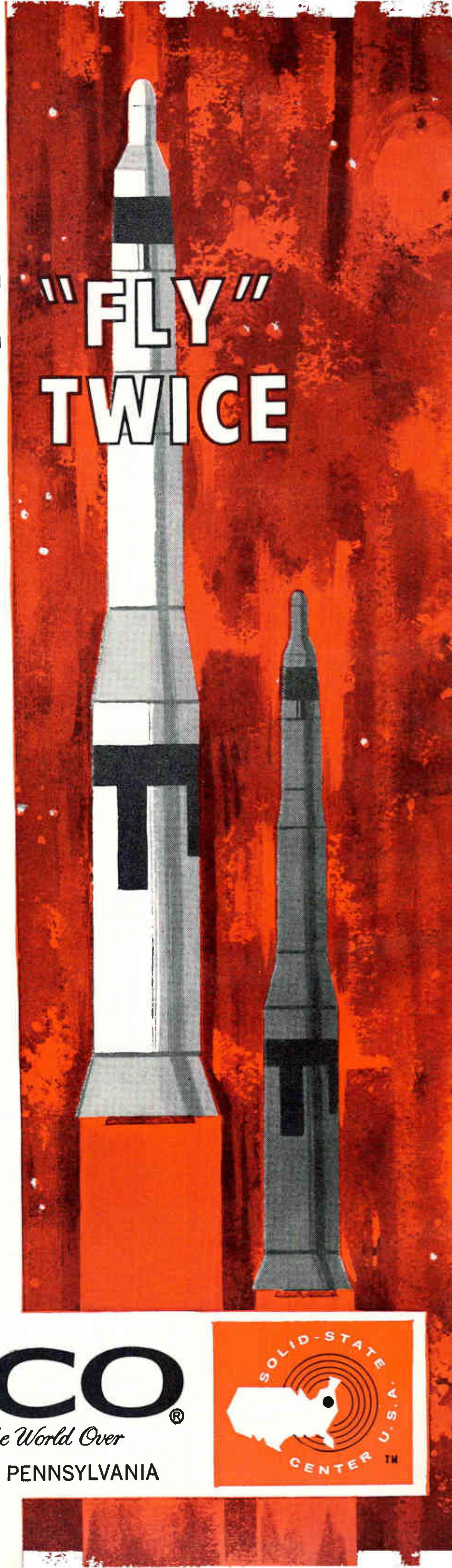

Philco SPAT* choppers, industry's most reliable telemetry multiplex switches, assure highest fidelity in multiplexing data from a missile's many sensors such as strain gauges and thermocouples—data that is the only legacy of a multi-million dollar missile flight. For this data is used in post-flight simulations which, in effect, make the missile "fly" twice.

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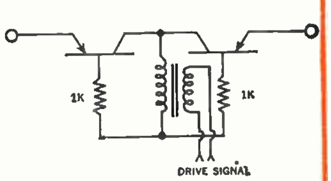
3. *Guaranteed Match over a temperature range—25° to 85° C;*
4. *Guaranteed maximum offset voltage for a wide range of base current values;*
5. *High gain-bandwidth product;*
6. *Meet all requirements of MIL-S-19500B.*

TYPICAL CHOPPER CIRCUIT



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Emitter Voltage, BV_{ECO}	—30 volts
Collector Cutoff Current I_{CBO} (V_{CB}=—10V)	.001 μa max.
Emitter Cutoff Current I_{EBO} (V_{EB}=—10V)	.001 μa max.
Offset Voltage V_{EC} (I_B=—200 μa, I_E=0)	1.5 mv max.
Offset Voltage V_{EC} (2N2187 Matched pair, I_B=—1 ma at all temperatures from 25°C to 85°C.)	50 μv max.

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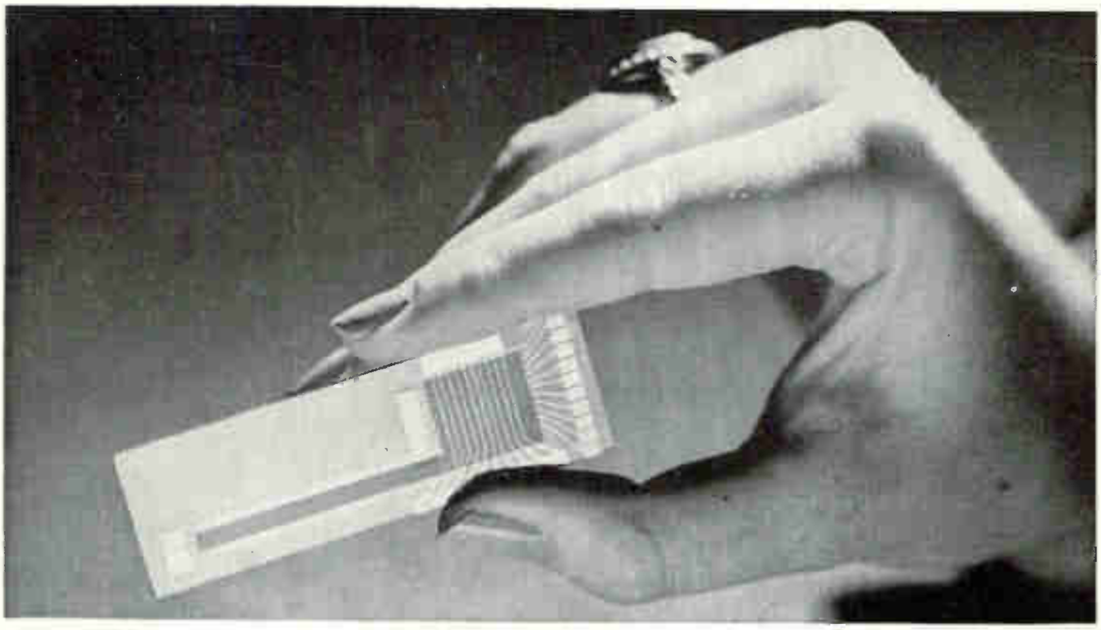

Continuous-sheet memory in a 10 × 10 array of memory cells was made by vacuum deposition of metallic and insulation layers

Superconductive Computers —

COMMONPLACE IN TEN YEARS?

An assessment of the state-of-the-art, including new approaches to the design of superconductive memories. Review of recent work on superconductive computers shows these expectations—

By THOMAS MAGUIRE,
New England Editor

• ALL-SUPERCONDUCTIVE computers will emerge from the laboratory into the marketplace within 10 years.

• High-capacity thin-film cryotron memories will provide the engineering wedge. but a minimum of 10^6 to 10^7 elements must be successfully assembled to justify the refrigeration cost.

• Superconductivity, "the ideal computing technique," is still in the research stage. but it may forge ahead of competing high-capacity, high-speed approaches in the long haul because the difficulties of batch fabrication have been met head-on from the beginning.

These are some of the conclusions voiced by superconductivity researchers at a summer seminar held at the Massachusetts Institute of Technology.

Cost graph (Fig. 1A) by Jan A. Rajchman of RCA Research Laboratories indicates threshold, in terms of elements, that must be reached before cryotron memory or logic can yield an economic payoff. Once threshold is reached, however, cost slope is gentle in contrast to competitive memory-logic assemblies.

The principal reason why cryogenics involve relatively high initial cost is liquid helium environment needed in superconductive devices. For years, the only commercially available equipment was the Collins helium cryostat produced by Arthur D. Little, Inc. ADL now has developed a new closed-cycle refrigerator, the Cryodyne. This does not use the technique of expanding a compressed gas against a piston. but employs a displacer that

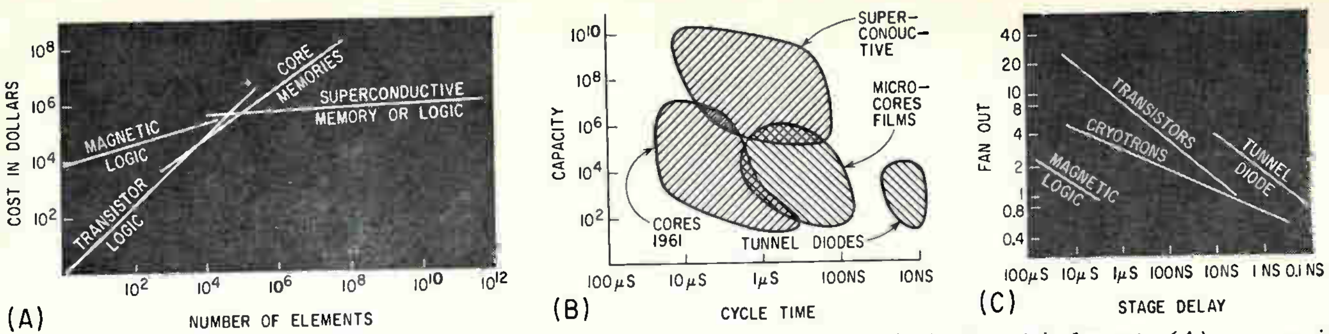

FIG. 1—Superconductive computer elements become competitive at a threshold of about 10^5 elements (A); cryogenic computer advantage lies in high-capacity memories (B); speeds for various types of logic are compared (C)

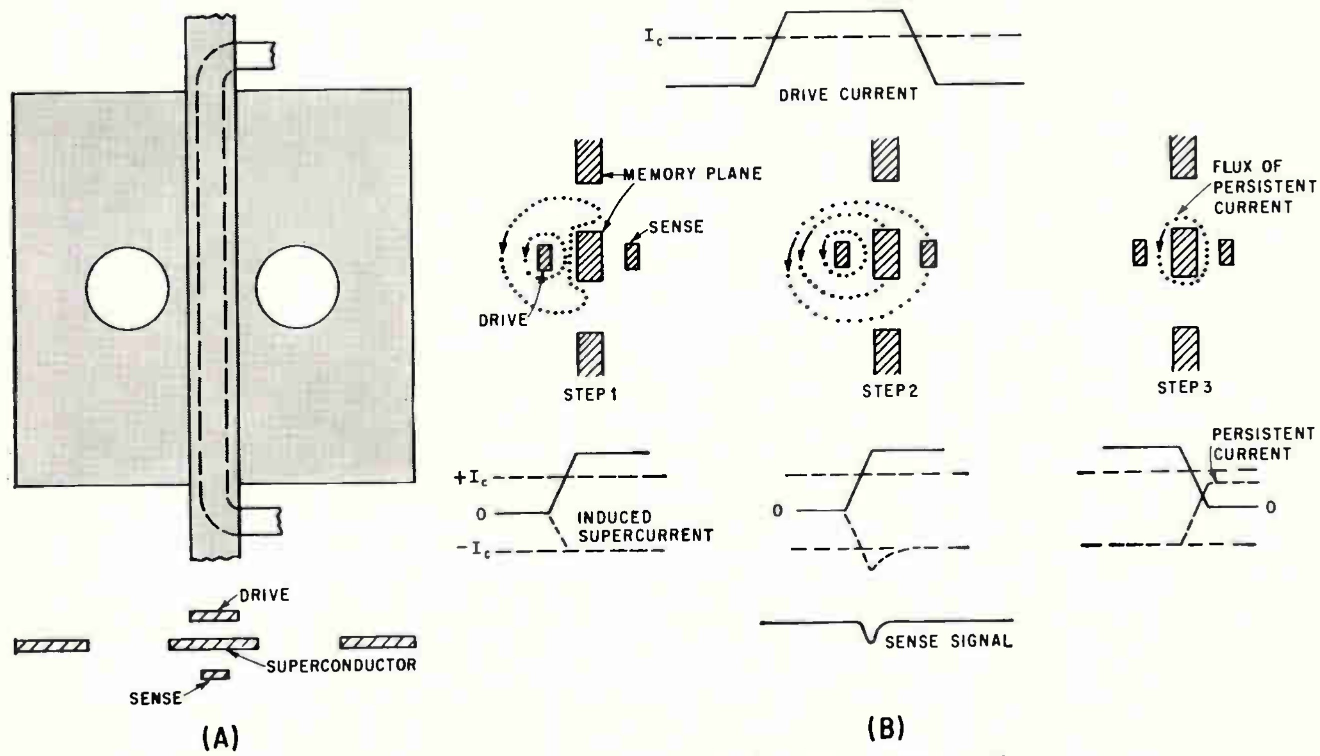

FIG. 2—Two-hole memory cell (A), and operation of this cell for information storage (B)

bounces the gas from one end of the chamber to the other through a heat exchanger. All valving is done at room temperature.

In recent years other companies have entered the field. These factors, plus increased demand for cryogenic environments, are expected to lower the equipment cost.

Significant advantage offered by superconductive components for memories is shown in Fig. 1B, also by Rajchman. Simultaneously with high-capacity capability, the cryotron or other superconductive component reaches into high-speed areas. Some cryotron researchers dispute the speed advantage conceded here to tunnel diodes and claim there is no reason why film cryotrons cannot eventually be competitive. Albert E. Slade of Arthur D. Little points out that, as of now, small cryotron memories driven by transistors can be made with cycle times of a few nanoseconds.

As visualized in Fig. 1C, however, Rajchman insists: "As of today, if you want speed at any price you have to use tunnel diodes. Nothing else—at the moment—can give you nanosecond-range circuits." In Table I, he summarizes relative positions of superconductive and other computer elements; he concludes that superconductivity offers significant over-all advantages, but "very patient efforts are needed to overcome the exceedingly difficult technology involved."

Regarding the cryotron's promise of high packing densities, Rajchman points out that as of today "high densities have not been achieved with either superconductors or tunnel diodes: but it's easier to fight the battle in the air than in liquid helium." On the other hand, V. L. Newhouse of G. E. says that 10 to 20 million cryotrons per cubic foot appears feasible.

Laboratory development teams vary widely in opinions about the difficulties of cryotron fabrication technology. However, no one has yet assembled memory or logic assemblies of the order of 10^5 to 10^7 elements. Neither has anyone reported multi-plane cryotron memories. One of the problems with multi-plane memories is impedance matching between the low-impedance cryotrons and relatively higher impedance of transmission lines. IBM, however, is working on multi-plane cryotron circuits, using transformer connections.

Proponents of superconductive computing techniques maintain that cryotrons lend themselves more readily than other components to batch fabrication. Today's workers are aiming, not just for assemblies that work, but for those which realize the full potential of cryotrons in high speed, low cost and reliability.

Problems of insulation and interconnections are annoyances rather than basic obstacles, they claim. And historically minded researchers like Newhouse of GE point to the analogy with magnetic core memories. Development of cores started in 1946, but it wasn't until 1953 that working core memories were achieved. The late Dudley Buck of MIT announced the first cryotron in 1956, but this wire-wound version later gave way to the faster thin-film type.

"Mass fabrication promise of cryotrons has been borne out already," says Donald R. Young of IBM. "They require perfection that other components do not; but once you get what you want, reproducibility will come along with it."

One limit to cryotron speed at present is imposed by the speed of transistors which drive them—giving rise to the proposal that tunnel diodes be employed as drivers. An alternate proposal is use of cryosars for driving cryotrons. The cryosar is not a superconductor, but a semiconductor which operates on the basis of impact ionization of impurities—a bulk effect—in a liquid helium environment. A. L. McWhorter of MIT Lincoln Laboratory says cryosars can be made to operate at a speed of 10 nanoseconds or a little better.

Cryogenic computers may not necessarily use cryotrons. Entirely new elements may emerge from today's work—for example, employing thermal propagation for amplification and output. At the same time, researchers are exploring the possibility of fabricating cryotron circuits by use of electron beam technology or photographic etching instead of by evaporation. Under investigation at Space Technology Laboratories is formation of polymer insulating films by electron bombardment of a condensing siloxane vapor.

In addition, researchers do not feel bound to compete with the computer of today. The superconduc-

TABLE I — COMPARISON OF COMPUTER ELEMENTS

	Transistors	Tunnel Diodes	Magnetics	Superconductive
Logic Gain	High	Average		
Speed	100 Mc	1,000 Mc	100 Kc	100 Mc
Storage	With Stand-By Power		Without Stand-By Power	
Mass Fabricability	?	?	?	Good
Non-Linearity	Good	Average	Average	Excellent
Power/Element	1–100 Mw	10–100 Mw	10–500 Mw	0.01–1 Mw
Operating Temperature	Ambient			Liquid Helium

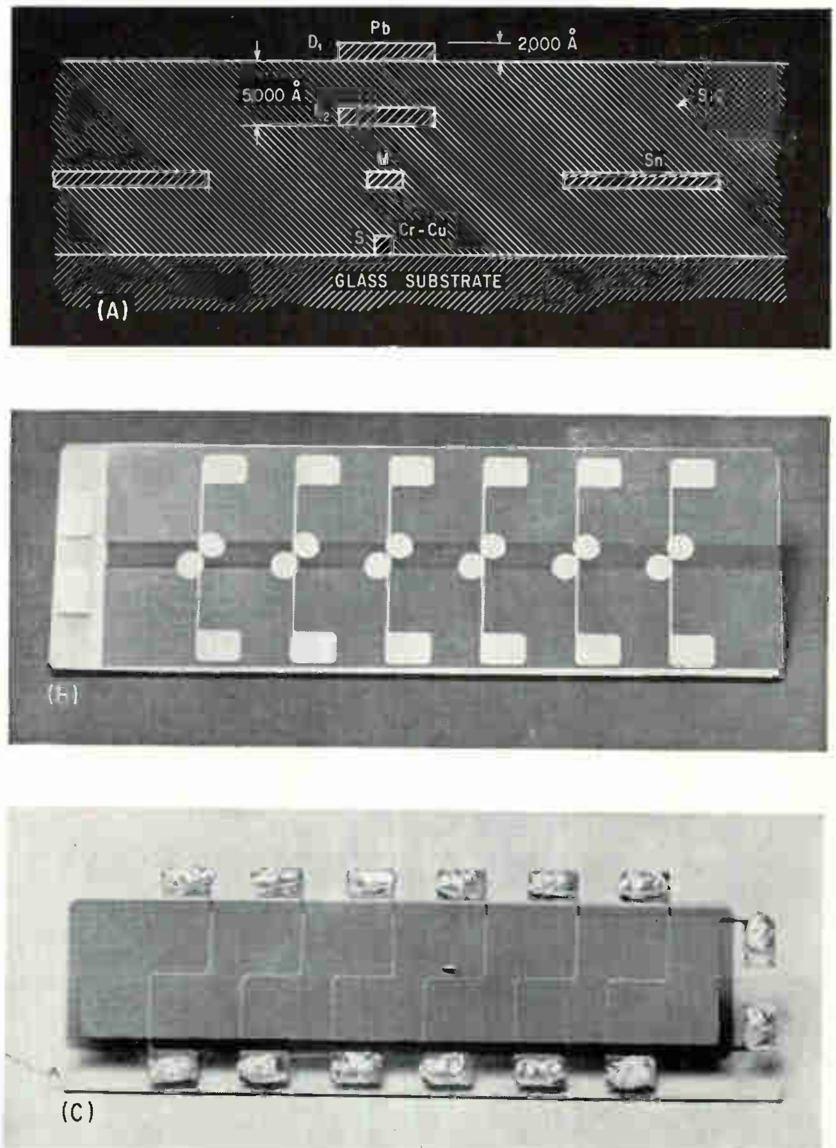

FIG. 3—Cross-section of persistent current memory cell (A); six-cell array, mounted on 1 × 3 inch microscope slide, uses only one drive line per cell (B); and continuous-plane type memory in a 6 × 1 array (C)

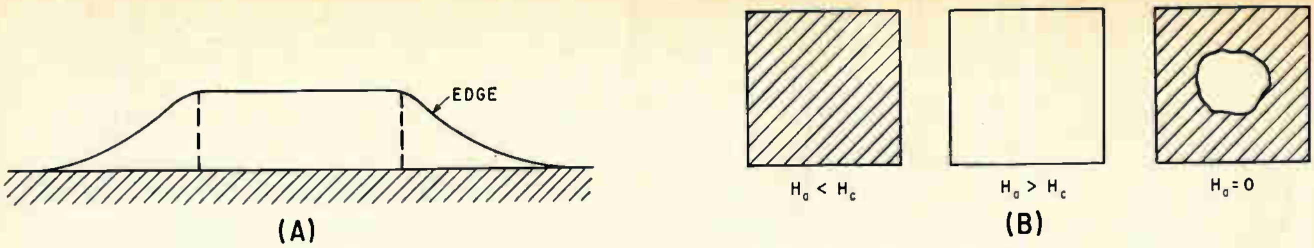

FIG. 4—Cross-section of evaporated cell with edge effects (A) and flux trapping in continuous superconducting film (after Alers) (B), where shaded portions represent superconducting areas

Table II — Superconducting Elements

Element	Tc°K
Technetium	11.2
Niobium	8.0
Lead	7.22
Vanadium	5.1
Tantalum	4.4
Lanthanum	4.37
Mercury	4.15
Tin	3.73
Indium	3.37
Thallium	2.38
Thorium	1.39
Aluminum	1.2
Gallium	1.10
Rhenium	1.0
Zinc	0.91
Uranium	0.8
Osmium	0.71
Zirconium	0.70
Cadmium	0.56
Ruthenium	0.47
Titanium	0.4
Hafnium	0.35

tive computer, taking advantage of the immeasurably small electrical resistivity and magnetic permeability of the cryotron—or a cryogenic component as yet undiscovered—may be able to have logic sophistication or logic-memory combinations not possible with other approaches.

Immediate potential of cryotrons is in high-capacity, low-cost memories. Long-range potential is in all-cryotron memory-logic assemblies.

But competitive techniques are moving ahead too. Transistors are getting cheaper, tunnel diodes are being explored for high-speed logic and memory assemblies. There are those who see the all-cryotron computer making an extremely high capacity research tool, but unable to meet the competition of ambient-operation computers for industrial and commercial applications.

A new approach to the design of a cryoelectric memory cell overcomes deleterious effect of edges in earlier two-hole cells and gives sharply increased reproducibility.[1] Called a continuous plane or continuous sheet memory, this new development by RCA embodies a simplicity of design that makes possible high packing densities while easing fabrication problems and costs. Planes of 100 cells have been made, and information can be stored in a cell in less than three nanoseconds.

Instead of having holes in the plane, use of a trapped-flux phenomenon in effect punches normal areas in a continuous superconducting film to store a persistent current. Continuous plane memories are easier to fabricate than other types of cryoelectric memories.

Like magnetic core memories, the continuous sheet is adaptable to X-Y selection schemes, but it exhibits no delta noise because of the shielding action of the superconducting plane.

By spacing the drive wires 10^{-2} inch apart and stacking 1,000 planes evaporated in glass substrates 10^{-2} inch thick, a packing density of 10^7 per cubic inch is possible. Memory cells in an array are easily accessible by a cryotron tree, and other semiconducting devices are being considered for higher speeds.

From among the elements and compounds that display the phenomenon of superconductivity (see Tables 2 and 3), tin and lead are used for the RCA continuous plane memory. Both are easy to handle, easy to evaporate or to plate. Efficiency of tin as a gate material for cryotrons approaches 80 percent (ratio of actual critical current to theoretical critical current). Lead has a high enough critical temperature to be useful as a control in cryotrons and as the X, Y and Z drives for memory arrays.

The continuous-plane approach to memory cells emerged from the drawbacks of the conventional two-hole memory cell, the latter consisting of a set of two holes in a superconductor with a narrow superconducting bridge between them as shown in Fig. 2A. Operation of this cell for information storage is shown in Fig. 2B. In Fig. 2B, step 1 illustrates the inability of the field of the drive current to penetrate the bridge because the latter is in the superconducting state. The superconductor opposes the change of magnetic field by creating an induced current in the bridge and around the holes exactly equal and opposite to the drive current. However, when the field reaches a threshold value called the critical field (equivalent to a certain critical current represented by I_c in the drive wire) it switches the superconducting bridge to the normal state and links a sense wire placed directly underneath the bridge (step 2), thus inducing in it a voltage proportional to the slope of the drive signal while the latter is still rising. Step 3 shows what happens when the drive signal is removed. It is assumed that after step 2 the bridge has returned to the superconducting state. Yet a field persists around it. In step 3, the driving field is removed, but since the superconductor allows no

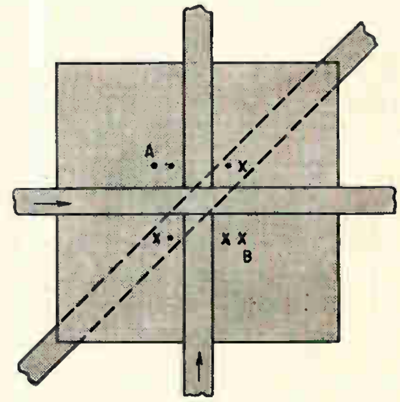

FIG. 5—Continuous-sheet memory cell

change of field (the field around the bridge cannot collapse without cutting it), a persistent current will be set up to keep the field as it was before. Magnitude of this current is about equal to the amount by which the drive current exceeds the critical value. A cross-section of this type of cell is shown in Fig. 3A, and an array of six cells using only one drive line per cell is shown in Fig. 3B.

Defects in uniformity and reproducibility prevent integration of cells such as these in large arrays for a high-capacity memory system. Even under careful evaporation conditions, the metal diffuses under the edges of the masks and produces a layer with edges as shown in Fig. 4A. Desired condition on the edges is represented by the dashed lines in the figure. High current density at the edges will make them switch to the normal state before the rest of the bridge, and the heat generated by this action can be sufficient to raise the temperature of the material above the critical value and bring it entirely to the normal state. Slight variations in the shape of the edges cause the switching action to occur at widely different current levels, resulting in a severe lack of uniformity.

Edge effects are eliminated by using a continuous plane for the memory. The persistent current is stored in superconducting regions surrounding normal areas created in the material by the magnetic field of the drive current. The flux of the persistent current is trapped in the normal portions of the material. Possibility of trapping fluxes in a continuous superconducting film has been shown in the literature, notably by P. B. Alers. His findings are summarized in Fig. 4B where shaded portions represent superconducting areas and nonshaded portions are in the normal state. It was found that as long as the applied field (H_a) remained below the critical value (H_c), the entire sample remained superconducting. For $H_a > H_c$, the sample was brought to the normal state; but after removal of the applied field, a portion of the material around the center remained in the normal state.

Implication is that a portion of the applied flux remained trapped in the material, and existence of this trapped flux automatically implies coexistence of a persistent current to sustain it. Pattern is indefinitely stable when the field is held constant. Thus it is possible to store a persistent current in a continuous superconducting film by punching normal areas in it.

Continuous sheet memory consists essentially of perpendicular strips of wire carrying the drive current over a thin superconducting plane to trap the flux. A sense winding is placed on the other side of the superconducting plane to detect the memory action, as in Fig. 5. Drive currents X and Y are sent in the direction shown by the arrows. The fields on the surface of the superconducting plane at the intersection of the drive conductors are represented by the dots and crosses near the intersection. They reinforce at the upper left and lower right sides of the intersection and cancel at the other sides. Result is a net concentration of flux at A and B.

Figure 6 shows how this flux can store a persistent current in a

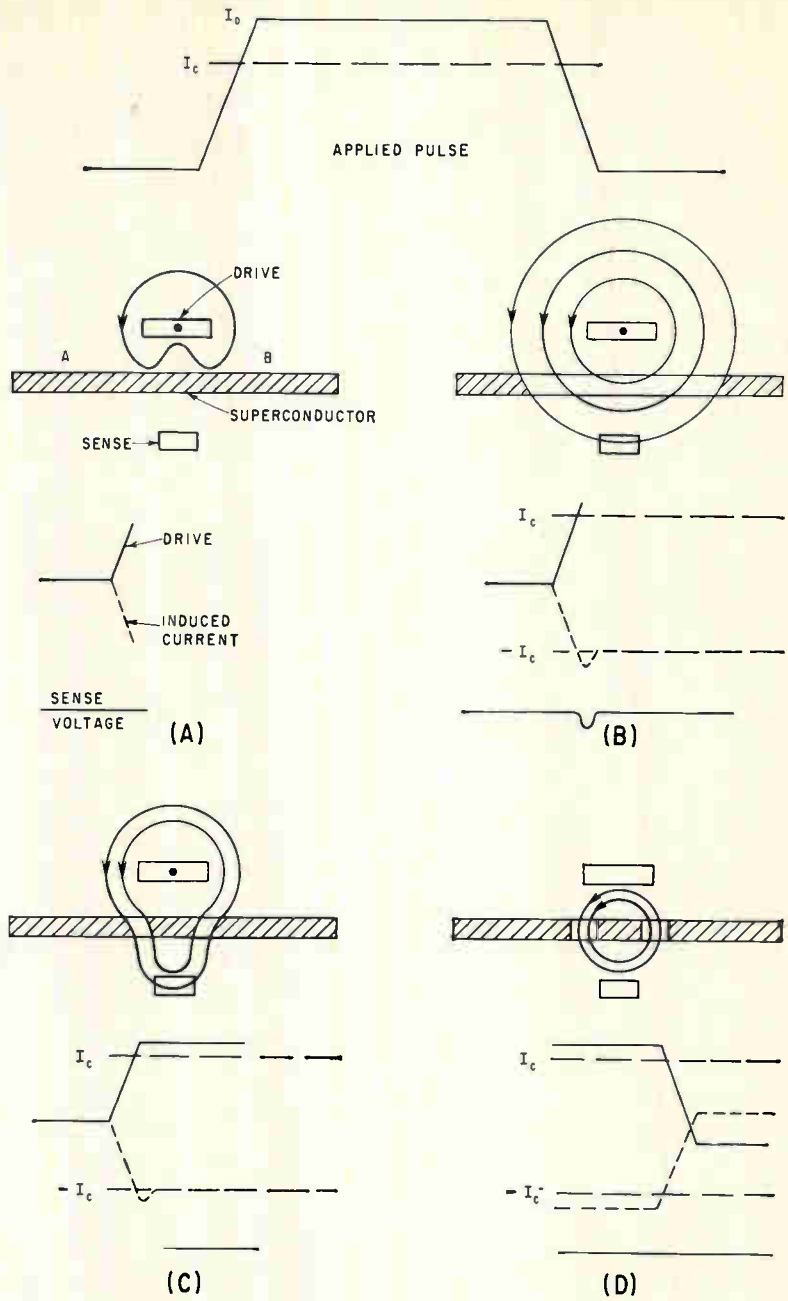

FIG. 6—In the continuous-sheet memory cell, the flux stores a persistent current in the superconducting plane

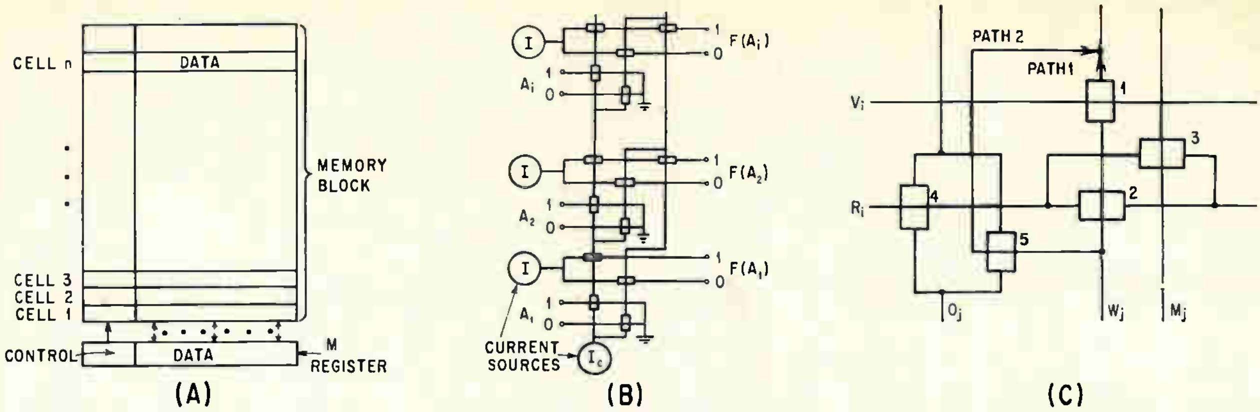

FIG. 7—Associative memory (A); $F(A_1)$ network forms basis for control module (B); typical bit is composed of persistent current loop and two AND gates (C)

Table III — Superconducting Compounds with critical temperatures

Compound	Tc°K	Compound	Tc°K
Nb_3Sn	18	SnSb	3.9
NbN	14.7	Tl_2Hg_5	3.8
MoN	12	$PbTl_2$	3.8
Nbc	10.3	WC	3.8
ZrN	9.5	ZrB	3.0
TaC	9.4	W_2C	2.7
MoC	7.9	Mo_2C	2.7
Pb_5Na_2	7.2	Sn_2Au	2.7
Pb_2Au	7.0	Sn_4Au	2.7
Tl_3Bi_5	6.4	VN	2.4
NbB	6	ZrC	2.3
Tl_7Sb_2	5.2	Au_2Bi	1.7
Mo_2N	5	CuS	1.6
MoB	4.4	PbSb	1.5
TaSi	4.4	$CoSi_2$	1.27
Sn_3Sb_2	4.0		

superconducting plane. Illustrated is a cross-section of a portion of the plane directly under the intersection of the drive wires at different times during application of a drive pulse on the *X* and *Y* wires of the device. Cross-hatched areas represent superconducting regions. The four parts of the figure represent states of the device when (A) the drive is below the critical value, (B) when it exceeds it and the plane switches, (C) during flat-top portion of applied pulse when flux configuration changes, and (D) when the drive current is removed leaving a trapped flux in the plane and a persistent current to maintain it. Direction of the flux and of the persistent current can be changed by reversing the polarity of the drive currents. Storage of persistent currents in the plane constitutes a memory action. A positive current can be used to write into the memory and a negative current of the same amplitude to read. The sense signal appears during the portion of the leading edge of driving pulses starting when the drive currents reach the value I_c.

Successful results of tests on a 6 × 1 array of memory cells of the continuous plane type (Fig. 3C) have led to design and construction of a 10 × 10 array (shown in lead photo), made by vacuum deposition of the metallic and insulation layers. Metallic layers are 2,000 to 3,000 angstroms thick, insulation layers 5,000 to 15,000 angstroms. Deposition was carried under a vacuum of 10^{-6} to 10^{-7} mm of mercury. Evaporation was carried through masks made by photoresist etching techniques. With special care, lines 10^{-3} inch wide are obtainable. The material used for the memory plane is tin, which has a critical temperature of 3.7 degrees K. The drive and sense lines are vacuum-deposited lead. Lead is a superconductor at the temperature of operation, 3.6 degrees K, and therefore consumes no power. Insulation is silicon monoxide, with special techniques used to obtain layers free of pinholes. Thickness of the layers is controlled by a calibrated crystal oscillator whose frequency is varied according to the loading effect due to the thickness of the layers, the crystal being placed inside the vacuum system.

Width of the drive lines is 10 mils, which is convenient for this operation but is not a physical limit on final size of the device.

Among cryotron memories under development is an associative or content-addressable type at Space Technology Laboratories.[2] Such a memory is addressed directly by its stored contents rather than indirectly by the labeling addresses used in conventional random access memories. Any record can be found by a simultaneous rather than sequential search of all cells, and any combination of bits can be used as the basis for the search.

Most promising uses of the associative memory, says A. J. Learn of STL, would be in applications where its high speed searching capabilities are utilized. This property can be made use of in a memory of moderate size where a small file is interrogated at a high rate, in active inventory maintenance, for example; or for machine language translation—look-up of words from a dictionary.

Larger associative memories would be useful in: military intelligence analysis, air traffic control, telephone service look-up where cross-filing is a real problem.

As an integral part of a learning machine, the approach would be not to operate it at the neuron level but rather to imitate a well known functional property of the brain—association of ideas, recall of stored memories with short access times when given a cue or key.

Essential idea of an associative memory is use of simultaneous logic in each cell to select a specific cell for reading, writing or clearing.

For writing, associative memory allows storage of a record without specifying any memory address; it is not necessary to know which cells are full or empty since the first empty cell is selected by logic in the memory.

For reading or clearing, record is identified by a key carried as a part of the record, so no address need be specified. Key may be any part of record, that is, each bit can be used as both key and data. This permits unlimited cross-filing within a single file. With a key specified, a simultaneous search is made in all cells of the memory, and the record with matching key is selected for readout or clearance, that is, matching of the keys gives access to all the information stored in a given memory cell. Key can be masked in reading or clearing so that agreement in the unmasked portion of a cell is sufficient to cause its readout or clearance. Key or masked key must uniquely identify a record in reading, but need not for clearing. And memory provides parallel readout.

Structure of memory is shown in Fig.. 7A. Each cell is capable of storing a single record. The M register is used for all control of, and communication to, the memory block—for writing, matching, reading or clearing. The M register might be constructed of standard transistorized circuits outside the cryostat, while the memory block is composed entirely of cross-film cryotrons.

Logic associated with each cell can become complicated. In writing, for example, selection of the first empty cell necessitates a decision at each cell which is a function of the states of all previous cells. The $F(A_i)$ network in Fig. 7B can perform such a selection and forms the basis for the control module. The function $F(A_i)$ has the property that it is true if input A_i is true and for all $j < i$, A_j is false. If the ZERO state is taken as false, then operation of such a circuit is fairly clear. The branches ZERO, ONE for A_i might correspond to the two states of a flip-flop.

A typical bit is shown in Fig. 7C. It is composed of a persistent current loop and two AND gates. If this cell is selected for writing by $F(A_i)$, which is now denoted as V_i, this makes gate 1 (the gate of a gated persistor) resistive. Information to be written is transmitted along bit line W_j, a current I representing ONE, no current representing ZERO. Current I initially divides between paths 1 and 2 of the persistor inversely as their inductances. The current in path 1, which is resistive due to current in V_i, produces a voltage that causes the current to be transferred to path 2; V_i is then turned off and the current distribution between the two paths remains fixed; W_j is then turned off and persistent current is established in the persistor to keep the flux linking the persistor constant (a requirement when the persistor is entirely superconductive). The presence of a persisting current represents a stored ONE. If no current were transmitted along W_j, the resistance of gate 1 would destroy any previously circulating current and no new current would be established. Therefore a stored ZERO is represented by no persisting current. In an unselected row, no emf is ever developed around a loop so that the final value of persisting current is equal to the initial value.

The complete control module is shown in Fig. 8 and contains 12 cross-film cryotrons. It is mechanized from the $F(A_i)$ network, a flip-flop and AND gates. In writing, the sequence of pulses and their functions are as follows: W_1 selects first empty cell whose state is indicated by the flip-flop, and W_1 transfers I from V_i to V_i; W_2 changes state of flip-flop to *busy;* W_3 transfers I from V_i to V_i after writing is accomplished. Pulse W_3 is applied previous to matching to get all currents in R_i lines. After the matching process, current flow in R_i indicates that the key of the cell matches the key in the M register.

Access time for retrieval of information is estimated at about 0.2 μsec. Times for clearance of a record are comparable since the same matching process is involved. Once an empty cell has been selected, writing times are also comparable since the primary time delay is then associated with the two reversals of current in the V_i loop.

A bit-organized memory driven by cryotrons and designed for speed is in the research stage at IBM. Motivation behind the memory is development of an all-cryotron computer. "A fascinating possibility, but there are plenty of problems," comments Nathaniel Rochester of the IBM Research Laboratory. The 256-bit memory requires 2,435 cryotrons plus 1,118 for reset—or 3,553 in all. Power input is 24 milliwatts. In the worst case, signal would have to go through 11 loops. Using alloy film gates, insulation thickness of 5,000 A, calculations indicate loop time of 1 nanosecond, so memory cycle time would be 10 or 20 nanoseconds. Using 6 mil wide lines, it is estimated that memory could be put on 4-inch by 4-inch substrate. Researchers are admittedly some distance away from actually building circuits like this with nanosecond speed.

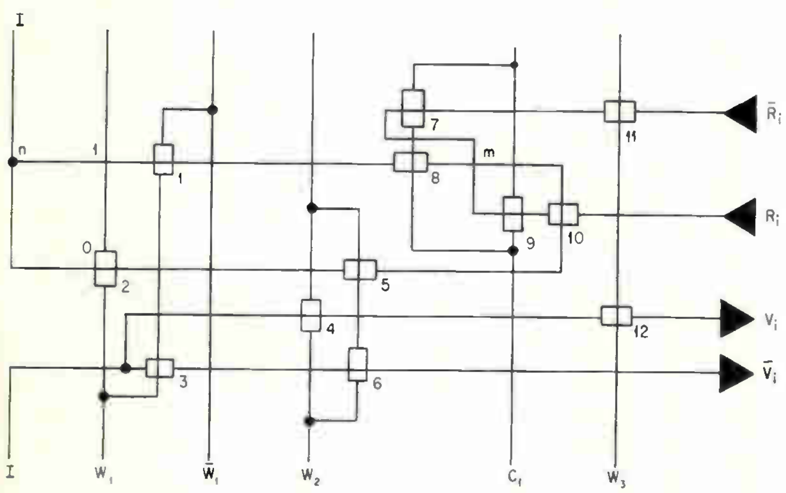

FIG. 8—Complete control module contains twelve cross-film cryotrons

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TUNNEL DIODES FOR

High inherent speed of tunnel diodes make them attractive for trigger

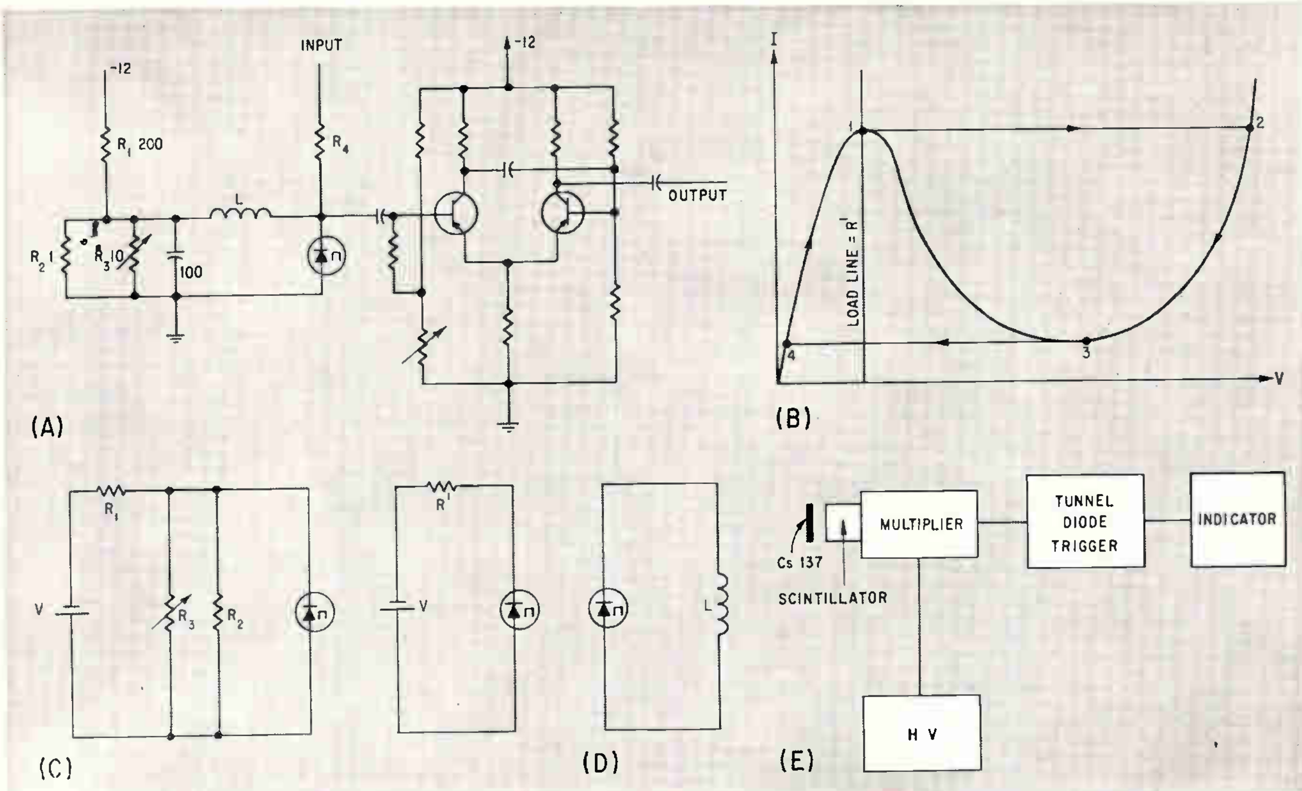

FIG. 1—Tunnel diode in sensitive low-level trigger circuit (A) drives Schmitt trigger. Load line on diode characteristic (B) is nearly vertical. Equivalent circuit of d-c biasing (C); a-c equivalent circuit (D). Typical application (E)

By SAMAUN,

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SEVERAL advantages are obtained with a trigger circuit that operates with low-level inputs. One is the component economy possible, since an amplifier is not required to amplify pulses to the level usually required for trigger circuits. This factor is especially important in multichannel arrangements such as in multicoincidence measurements. Also, the introduction of an amplifier tends to degrade the linearity, reliability, stability, signal to noise ratio, and speed of the complete trigger circuit.

The difficulty in constructing a sensitive trigger circuit has been in finding a circuit that exhibits a sharp transition region and a sufficiently fast response. The tunnel diode has been investigated for the application and has been found well suited to it. In the complete circuit, Fig. 1A, the tunnel diode is used as a primary trigger, feeding into a normal transistor Schmitt trigger.

The right hand part of the circuit is a conventional Schmitt trigger using mesa transistors (Siemens Mesa AFY 10), such as to give an output pulse approximately 0.2 microsec wide and −2.5 volt in amplitude. This circuit transforms the 300-milivolt, 0.2-microsec pulses from the tunnel-diode primary trigger into a usable level. The left-hand side of the schematic is the tunnel-diode trigger.

In the trigger part of the circuit, the tunnel diode is d-c biased close to its maximum current (Fig. 1B) by voltage divider R_1 and R_2, R_3; R_3 is used as a fine control of the working point. A Thevenin equivalent circuit for the d-c biasing can be made (Fig. 1C) which shows that the effective load line R' is smaller than 1 ohm (d-c resistance of L is

LOW-LEVEL TRIGGERS

applications. Sensitive low-level circuit uses tunnel diode to drive Schmitt trigger

neglected); the result is an almost vertical load line in the I-V plane. The a-c equivalent circuit is given in Fig. 1D.

Inductance L can be neglected over that part of the tunnel diode characteristic where the voltage jumps from point 1 to 2 and from 3 to 4. From point 2 the voltage starts to decay, following the I-V characteristic of the tunnel diode.

$$L \frac{di}{dt} - V(i) = 0$$

$$dt = L \frac{di}{V(i)}$$

$$t = L \int_2^3 \frac{di}{V(i)}$$

The pulse length can be calculated by integrating the I-V characteristics of the tunnel diode between points 2 and 3, and on the right-hand side of the maximum. Current sensitivity of the trigger was measured by connecting in series several values for R_4, and measuring the input pulse height necessary for triggering; this characteristic is plotted in Fig. 2.

From Fig. 2 the trigger current sensitivity is determined as 6.5×10^{-6} amp. Energy content of the triggering pulse was large compared to the triggering energy needed, so the relation only gives an idea how close to the peak (transition region) the circuit can be driven and still act as a monostable device.

The next requirement, fast response, is a property of tunnel diodes, so no problems arise in this area. The tunnel diode used is a Siemens type Tu. 2, with a maximum oscillating frequency of $f_{max} \approx 140$ Mc.

A practical application of the low-level trigger circuit is to connect it directly into a scintillator-multiplier arrangement without amplifier or cathode follower. In this application the charge arriving at the last dynode of the multiplier has roughly the form

$$q = Q_\infty (1 - e^{-t/\tau})$$

Term τ is scintillator decay constant, $\approx 10^{-7}$ sec for NaI(Tl). Term $Q\infty$ is approximately 10^{-12} coulomb for a typical application. For a current pulse of the form

$$i = \frac{Q_\infty}{\tau} e^{-t/\tau}$$

a current peak of about 10^{-5} ampere occurs at $t=0$.

The arrangement is shown in Fig. 1E. The input of the tunnel-diode trigger is directly connected to the collector dynode of the multiplier-phototube (EMI 9536 B), with cesium 137 as the radioactive source. Triggering action starts at approximately 600 volts.

An integral discriminator can be designed by several approaches. One scheme is to vary the bias voltage, giving a nonlinear voltage to pulse height relation, which is given by the tunnel-diode curve. Alternatively, the high voltage can be varied, giving a logarithmic relation between pulse height and high voltage.

Dynamic range of the trigger circuit is excellent, as seen from the steep I-V characteristic of the tunnel diode beyond its current minimum, and considering that the tunnel diode can be pulse-loaded up to four times its peak.

To use the circuit in practical cases, several refinements still have to be introduced. One refinement is temperature stabilization. To use the circuit as a normal trigger, where trigger pulses are relatively high and uniform, the primary concern is to prevent the circuit from becoming an astable device, due to the decrease of current and voltage of the peak by increasing temperature, and hence bringing the working point to the negative resistance side. Where the effective d-c load line R' is almost vertical so that the current change can be neglected, temperature stabilization should make the effective voltage source move to the left faster than the peak does. A more stringent requirement exists when using this circuit as an integral discriminator; as a first approximation it is then required to follow the peak accurately. The disadvantage of this circuit is that no simple arrangement can be found for using it is a differential discriminator. The difficulty arises in obtaining two separate channels, which have to be checked for anticoincidence.

By reversing battery and tunnel diode polarities, the circuit can be made sensitive to positive pulses. The tunnel diode has been found to behave excellently in low-level trigger applications. It is useful as an integral discriminator, but no simple arrangement has been found for using it as a differential discriminator. Applications for the circuit are in areas where component economy or weight is important, or in coincidence circuits where low-level triggers are needed to minimize coincidence uncertainties caused by the impulse form.

Experimental work on the circuits was done at Siemens and Halske, Strahlungs mesz Labor, Karlsruhe, West Germany.

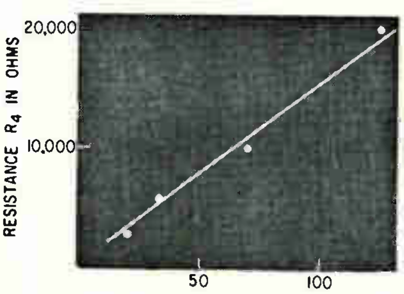

FIG. 2—Trigger current sensitivity is about 6.5×10^{-6} amp

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LASERS:

The last article of a four-part series describes scientific, medical and other laser applications, laser optical systems and commercial equipments

Laser-crystal stimulator is viewed by scientists (Edgerton, Germeshausen & Grier)

By LEON DULBERGER
Assistant Editor
SY VOGEL
Associate Editor

SCIENTIFIC APPLICATIONS of lasers will make use of their monochromaticity, high intensity, coherency and directionality.[1,2,3] Among these applications are creation of a new set of length-time standards, spectroscopic experiments, and tests of the special and general theories of relativity.[3,4]

Up to now, physicists have measured wavelength, rather than frequency, of infrared and optical radiation. Frequency f is computed from $f = c/\lambda$, where λ is wavelength and c is the velocity of light, which is accurate to about 1 part in 10^6. Figure 1A shows a possible arrangement for obtaining infrared and optical-frequency standards; with this arrangement, it is not necessary to know or measure wavelength to obtain a frequency standard.[3] Here, the r-f output of a maser can be used as the standard frequency (f). Conventional methods would be used to produce harmonics throughout the r-f range, using such components as silicon crystals as harmonic generators. At about ½ mm, a laser (consider lasers as a family of devices that produce coherent radiation above r-f) would be used to amplify the desired harmonic ($2nf$). New materials that have nonlinearities will be used as harmonic generators at infrared and optical frequencies. The harmonic-generator material could be external to the laser amplifier,[5,6] as shown in the drawing, or within the laser's resonator (cavity).[6] Thus, successive doublings of standard frequency f provide a chain of accurate standard frequencies throughout the r-f, infrared and optical spectrums.

Since optical-frequencies produced by the frequency-doubling chain will be known to a greater precision than 1 part in 10^8, the precision to which length can be determined, the velocity of light can be calculated[3] to 1 part in 10^8. Thus, the frequencies provided by the doubling chain can be used as standards of both time and length since $\lambda = c/f$.

Figure 1B shows how lasers can be used in spectroscopy.[3] Frequency of the laser oscillator is swept over the tuning range of frequencies. The specimen under test absorbs radiation at frequencies characteristic of the specimen. This absorption is sensed by the detector. Thus, the monochromaticity of a laser can be used for high-resolution spectroscopy, particularly in the spectral range between microwaves and the near infrared.

Devices and Systems Part IV

Figure 1C shows a possible arrangement for using a laser in high-resolution Raman spectroscopy.[3] When light comprising spectral lines of high intensity is beamed onto a transparent material (gas, liquid or solid), the scattered light emanating from the material contains extra spectral lines that are slightly above and below each of the incident spectral lines; this phenomenon is the Raman effect and is ascribed to the change in rotational or vibrational energy of the scattering molecules that is caused by the incident light. In Figure 1C, Raman-scattered light emanating from the test sample and light having the frequency of the incident beam are mixed by the photocell detector. The spectrum analyzer indicates the frequency shift due to Raman effect.

Lasers might be used in a Michelson-Morley-type experiment to test the possible existence of an ether pervading the universe.[3] The Michelson-Morley experiment tried to detect motion of the earth through an ether by using an interferometer to sense changes in interference fringes; movement of the fringes would have shown that the ether had an effect on the velocity of light. No effect was detected. Figure 2 shows a possible arrangement for performing a Michelson-Morley experiment with lasers. The photocell mixes the two laser frequencies and detects changes in the lasers' relative frequency that could be caused by shifting the laser orientations with respect to the ether drift; other orientations would be tried, in addition to those in Fig. 2, which shows the setup in two positions that are 90-deg apart. The high monochromaticity of lasers may result in experimental precisions that are 10^4 times greater than attained by other ether-drift tests.

Potential medical applications of lasers include surgery. A laser light beam might be used to suture (stitch), sterilize or cauterize extremely small areas. Experiments on rabbits have used the eye of the rabbit as a lens to focus laser light on the retina; strength of the beam was low enough to pass through the rabbit's eye without damaging it, yet high enough—after eye-lens focusing—to produce retinal sutures.[7,8] The high intensity and coherency of laser energy make applications of lasers to surgery appear promising. Focusing arrangements may be capable of focusing high-energy intensities on an area approaching a wavelength in diameter, without harming body material between the focal-point area and the focusing lens.

This series of articles has not

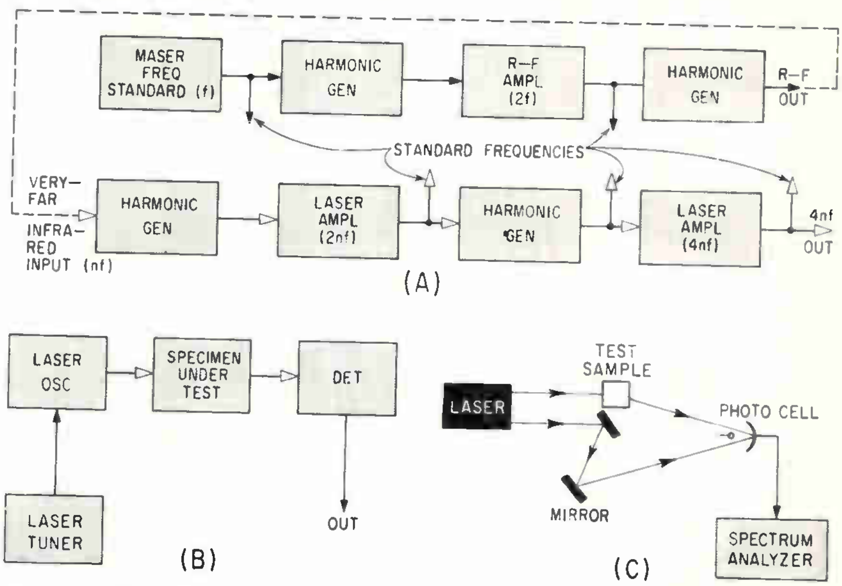


FIG. 1—Frequency-standards system (A) does not show all blocks, as indicated by broken line. Typical laser-spectroscopic setup is shown in (B) and setup for Raman spectroscopy is shown in (C)

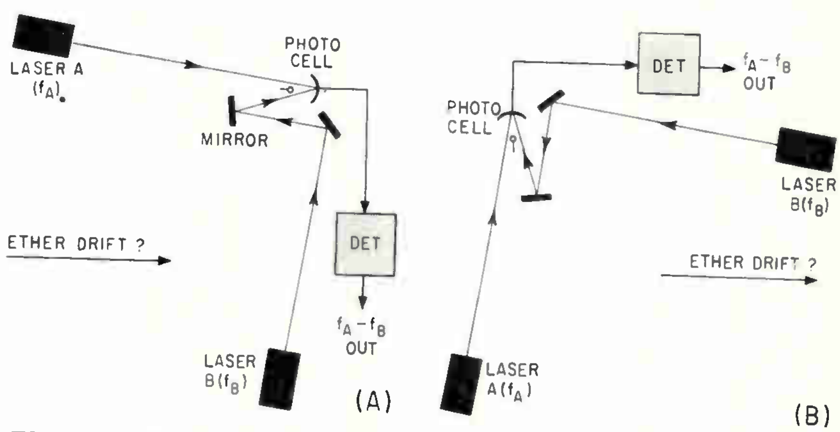


FIG. 2—In this experimental arrangement to test the possible presence of an ether, setup in (A) is rotated 90 degrees to position shown in (B)

discussed all proposed applications of lasers. Here are other possible applications:

- Use lasers to transmit power in space, where attenuation would not be a problem.[9]
- Guide space satellites with laser-beamed power.[9]
- Use the high monochromaticity and intensity of a laser beam to control chemical processes.[10]
- Weld or cut material over areas whose diameters are in the order of a micron or less.[11]
- Sterilize minute areas for medical, biological, and industrial purposes.[11]
- Use a laser beam to take mapping—or other — photos of extremely high resolution.[11]
- Find out what happens to matter when it is subjected to the intense radiation that a laser produces. Alteration of molecular construction and disruption of chemical bonds in small regions inside homogenous substances are among the possible effects.[12]
- Use the high intensity and directionality of a laser beam for tracking[13] or for terminal guidance, that is, for homing on an enemy target or a friendly base or ship.[14]
- Make geodetic or weather measurements; for example, a laser transmitter and a light detector spaced a known distance apart can determine moisture content by correlating the amount of laser light absorbed by the atmosphere over the known distance.[15] A similar setup might function as an atmospheric-constituent analyzer.[16]
- Use lasers to make precise measurements at intermediate and final stages of fabricating and installing precise instruments and equipment.[13, 16] Checking the tolerance and alignment of a radar antenna is an example of this kind of work.[13] Other examples are: measuring indices of refraction, calibrating optical wedges, testing optical elements and photographing extremely small objects.[17]

The laser's high intensity and monochromaticity can be used to advantage in interferometry, precise image formation, and in diffraction studies.[17] Ruby lasers may be used as a light source to form sharp images in photography. Its monochromaticity eliminates the problems associated with chromatic abberation, and its high intensity permits short time exposures of even slow-acting photographic materials; short exposures enhance image formation and reduce the effects of vibration during the exposure. Image quality is ten-times better than that produced by incandescent-light sources.

Figure 3A shows a setup for producing a duplicate(s) of the master reticle on a photographic plate; this plate comprises a photoemulsion on a glass slab. Figure 3B (inset) shows another laser-lens configuration that could be used to expand the cross-sectional area of the beam.

High-resolution images such as the reticle on the photographic plate in Fig. 3A can be studied by analyzing the diffraction images that they produce.[17] Data on reticle-line width and reticle-circle diameters may be obtained by photographing the diffraction pattern, using laser illumination.

Silver films may be used as photographic plates.[17] The laser beam that falls on the silver film evaporates silver, producing a negative image of the master being reproduced.

Lasers might be used in an interferometer setup to manufacture diffraction gratings.[17] The interference patterns produced on a photographic plate of conventional material can be used for coarse diffraction gratings. Fine diffraction gratings can be made by using the best photographic plates available.

External optical configurations of laser systems depend on the system application and on the characteristics of the beam emerging from the laser. Diffraction at the output mirror of the laser limits the minimum divergence of the laser output beam to about $\theta = \lambda/d$ where θ (in radians) is the angular divergence of the beam from the laser axis, λ is wavelength, and d is the diameter of the laser.[18] Beam divergence of the gas laser approaches the ideal limit set by diffraction but beam divergence of the ruby laser, which is typically about 0.01 radian, is far from the ideal[18] (about 70 $\times$ 10^{-6} radian for an 0.5-in. diameter ruby rod). External lens systems may be used to concentrate output-beam energy on a small area, as would be required in an application such as microwelding, or to make the output beam less divergent, as might be required in a communications system.

Figure 4A shows a laser communications system.[19, 20] Assume that all lenses and mirrors are ideal and that beam divergence is caused entirely by diffraction. Transmitting lens A focuses the laser output beam to a point that is the common focal point of lens A and mirror A. Divergence of the transmitted beam reflected by mirror A is then only λ/D;[18, 20] if the laser were aimed directly at the receiver, divergence would be λ/d. If attenuation by the transmission media is negligible, the approximate maximum collimation distance (L) is found from $L = D^2/\lambda$;[19] the broken line arrow indicates divergence angle λ/D, as well as the collimation distance of the beam.

Figure 4B shows an idealized telescopic two-lens system that focuses the parallel-ray input from a transmitting laser onto a point that is the mutual focal point of the eye and objective lenses.[18] Divergence of the transmitted beam is λ/D where D is the diameter of the objective lens.

These examples of communications-system optics assume that the lenses and mirrors are ideal and do not consider the effect of laser-beam divergence. In a two-lens system, for example, since the laser input beam to the eye lens is slightly divergent, the actual lens system that would be used represents a compromise between a telescopic and a collimating-lens system; a collimating-lens system would be used to direct divergent rays from a point source into a parallel beam.[18]

Commercial availability of lasers has now given researchers the chance to pursue systems development and apply the laser as a basic research tool, without building their own instrument. This obviates the need to invest months of time developing device construction skills.

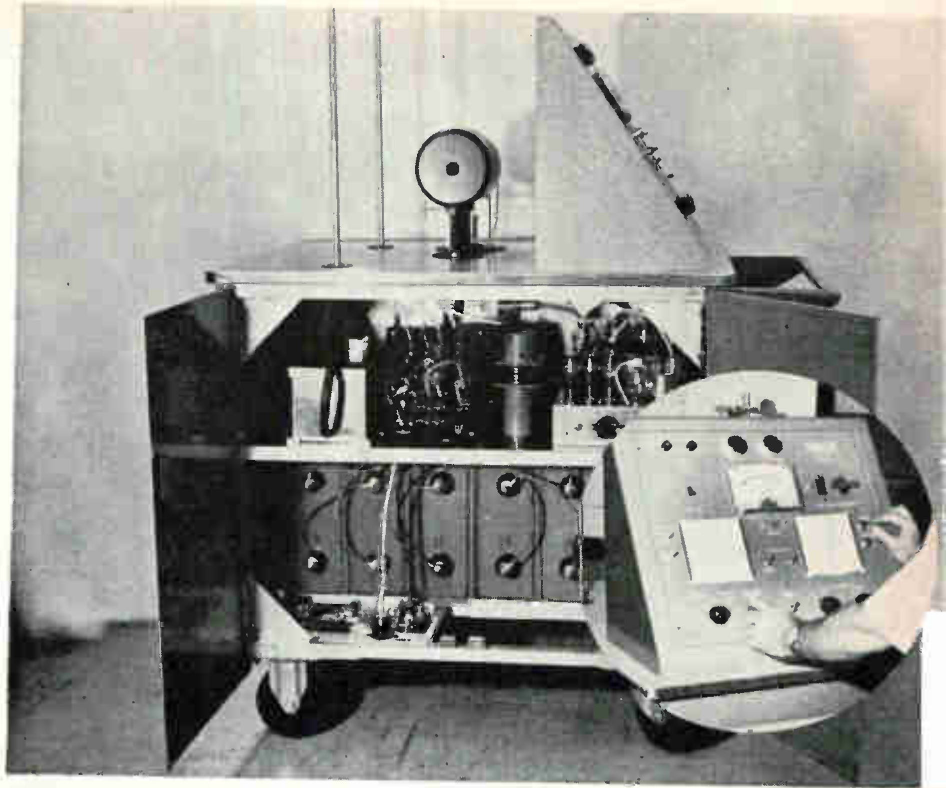
Lasers of small size and light weight as well as large high power units are available. Prices start at under $2,000 and exceed $50,000, for ruby instruments. Most employ a xenon flash tube as the optical pump. Some firms will supply external optical systems, designed to specifications, which adapt the instrument for optical ranging, spectroscopic, medical and other experiments.

Units in the megawatt range are being built. These lend themselves to "death ray" research, while slightly lower power units are applicable to medical burning and microwelding studies.

Small lasers, which operate on an input of 200 joules have been developed using efficient pump reflector configurations. Both Raytheon Corp., and Trident Corp. (see photo) build compact equipment, among others. These firms also make higher power instruments, along with Technical Research Group, and Trion Instruments Inc.

A complete laser stimulator, for pumping of different crystals is built by Edgerton, Germeshausen & Grier Inc. (see photo). Up to 10 flash tubes are provided, along with the power supply and related electronic circuits.

The authors acknowledge the help given by workers in industry, government and research. Some, but not all, of these people are listed in the references as having provided us with private communications.



High-power laser of Trident Corp., laser head at top. Panel knobs (inset) control capacitor-bank charging rate and firing rate

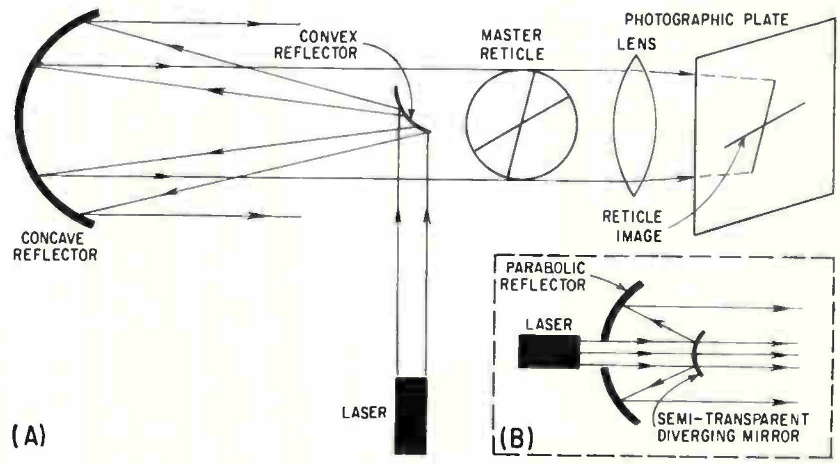


FIG. 3—Optical system for producing high-resolution images on photographic plate (A). Inset (B) shows a different arrangement for expanding the cross-sectional area of the laser beam (Keuffel & Esser)

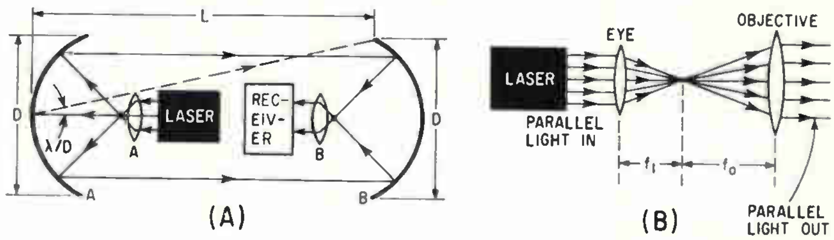


FIG. 4—Distance between transmitter and receiver of this communications system (A) would be far greater than indicated. Telescopic lens system (B) is drawn for hypothetical case of perfectly parallel laser beam

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K-Coronameter Observes the Sun's

Uses polarized-light technique and closely controlled narrow-band circuit to detect, observe and measure an otherwise invisible solar phenomenon

A SOLAR ECLIPSE allows scientists to observe solar features normally made invisible by light scattered in the earth's atmosphere.

One such feature is the electron corona, or K-corona. Sometimes called the white light corona, it emits light with a continuous spectrum, rather than one made up of emission lines as is much of the light of the inner corona. This continuous spectrum comes about because the light from the K-corona is light from the disk of the sun, scattered by free electrons. Scattering polarizes the light and thus provides a means of detecting it against light scattered by the earth's atmosphere, which is much less polarized.

Natural eclipses last only a few minutes and can be observed only at widely spaced intervals and places. With freedom of travel and with clear skies, an eclipse could be seen about every two years. Thus, little was known about the dynamics of the K-corona, and day-to-day changes in it could not be observed satisfactorily. It was not possible to say if the corona rotated with the rest of the sun.

Early attempts to see the corona by artificially creating an eclipse in a telescope failed because of scattered light in the instrument. Lyot built an instrument called a coronagraph that he used successfully at Pic-du-Midi in the French Pyrenees.[1] With a visual polarimeter sensitive to a proportion of polarization of 10^{-3}, he was able to detect the electron corona out to about 0.35 solar radius above the limb.[2] (The limb is the outer edge of the solar disk.) He also detected strong coronal emission lines, and since then most observations of the corona have been made with spectrographs or with narrow-band filters.

Emission-line observations are relatively easy out to about 0.3 solar radius from the limb of the sun, but are made difficult in the outer corona by a steep gradient in brightness in these lines.

The brightness gradient of the electron corona is much smaller. This makes it possible to detect this corona at a greater height above the sun. The instrument to be described has made it possible to measure the electron corona out to one solar radius above the limb; occasionally the corona is detectable out to two solar radii. To achieve this, the instrument must detect polarizations of the order of 10^{-4}.

Using data taken with this instrument, Newkirk has developed a model for the solar corona,[3] showing an increase in electron density over active regions and appreciably lower electron densities in the polar regions[4].

Several other papers leading to a better understanding of solar physics have resulted from some of the observations made with the K-coronameter.[5, 6, 7]

The optical system makes concentric scans around the limb of the sun or back and forth along selected arcs. This is done by causing the back of the instrument to trace a circle about a fixed point, with the front of the instrument mounted in gimbals. Light enters the objective lens, Fig. 1, and forms an image of the sun and corona on an occulting disk. The disk is oversized and has a center aperture through which light passes. The sun's image falls on the outer edge of the disk and is blocked from entering the rest of the instrument. Light from the corona passes through the aperture and a field lens into the polarization analyzer. The instrument is calibrated by inserting a piece of flat glass and tilting it with respect to the light beam to introduce a known amount of polarization.

The polarization analyzer consists of a quarter-wave plate, electro-optic-light-modulator (EOLM) and polarizer. The active element of the analyzer, the EOLM, is an electro-optic retardation plate of a Z-cut crystal of ammonium dihydrogen phosphate manufactured by Baird-Atomic, Inc. A voltage applied along the light path produces a retardation proportional to the voltage. Change of the voltage polarity interchanges the slow and fast axes of polarization.

The axes of the quarter-wave plate and of the EOLM are set to make an angle of 45 deg. with the plane of the entering polarized light. The direction of maximum transmission of the polaroid is set parallel to the incident polarized light. If, for each peak value of voltage applied to the EOLM, the retardation of the crystal is plus or minus a quarter-wave, then the quarter-wave plate and the crystal together act as a single plate having a retardation of either a half-wave or zero, and the polarizer

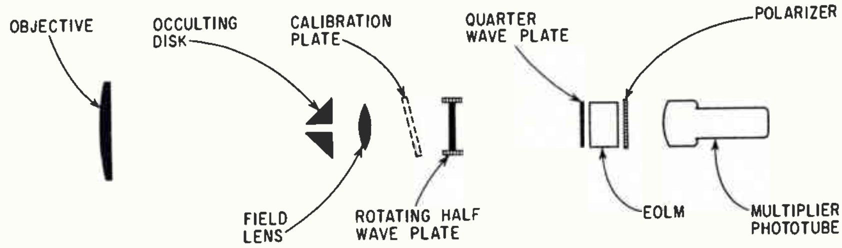

FIG. 1—Light rays are processed through electro-optical light modulator to multiplier phototube

Electron Corona

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High Altitude Observatory,
University of Colorado,
Boulder, Colo.

Large dome contains K-coronameter. To reduce scattering by atmosphere, observatory must be located as high up as possible

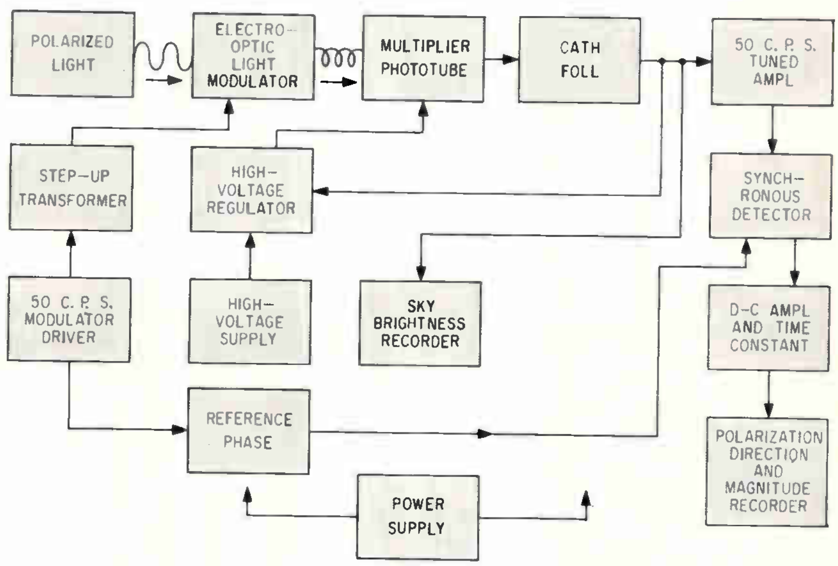


FIG. 2—K-coronameter optical-electronic system

stops or transmits the light. For voltages intermediate between peak values, the amount of transmitted light is approximately proportional to the applied potential.

The polarization analyzer is analogous to a simple polarizer placed in the light path, and then rotated at a speed that will modulate the polarized component at the proper frequency.

Light from the corona is polarized in a plane radial to the sun. During one scan around the limb, the plane of polarization is changing continuously, and it is desirable to rotate the plane of polarization of the coronal light so that the plane of the polarized light which enters the analyzer is always the same. This is done by rotating a half-wave plate ahead of the analyzer at half the rate at which the instrument scans around the sun.

After the analyzer, the light is received by a multiplier phototube. The light falling on the phototube has two components. The first is a large steady-state component resulting from unpolarized light passed through the analyzer unmodulated, which represents sky brightness resulting from scattering of light by dust and water. The second component is a small a-c signal resulting from polarized light modulated by the the analyzer; this component contains most of the information of interest. Since the polarization component changes to be detected are small—of the order of one part in ten thousand—a system with optimum signal-to-noise ratio is needed. This can be achieved by two different techniques. The first is by optimizing the detection device; to accomplish this, Dr. Lallemand of the Paris Observatory manufactured a special multiplier phototube. Its most important feature is an end-on semitransparent photocathode with a high quantum yield at the wavelengths around 5200 A. It is a 7-stage multiplier operated with about 900 volts across the dynode string. This low voltage results in low gain, but gives the most favorable signal-to-noise ratio.

The output current of the multiplier phototube produced by the light striking the photocathode is

$$I_p = \mu \, i_p \qquad (1)$$

where the photocurrent at the cathode is i_p, and μ is the gain of the multiplier phototube. The rms value of the output current originated by thermionic emission and by the shot effect from the photoelectrons is closely approximated by

$$[(I^2)_{av}\Delta f]^{1/2} = \mu[(2e\,\Delta f)(i_t + i_p)]^{1/2} \qquad (2)$$

where e is the electronic charge, Δf the bandwidth of the receiving instrument, i_t the thermionic emission from the cathode and i_p the photo-current at the cathode. This ignores the small thermionic emission from the secondary elements and also the random process of secondary emission which adds about 15 percent to the predicted noise. Since operation is at relatively high light levels, thermionic emission is no longer important.

Letting S_N represent the signal-to-noise ratio obtained by dividing Eq. (1) by (2)

$$S_N^2 = \frac{i_p^2}{2e\, i_p\, \Delta f} \qquad (3)$$

Then from Eq. 3, as the photocathode yield i_p is increased, the signal-to-noise ratio and the overall sensitivity of the tube may be considerably improved for recovery of small modulation components in the presence of large steady-state components. Also, if the bandwidth, Δf of the receiving instrument is made small, a further improvement in signal-to-noise ratio results.[8]

The signal from the phototube is fed to a narrow-bandwidth amplifier, then synchronously detected, see Fig. 2; that is, the output from the phototube is compared with the driving voltage applied to the light modulator. The detected output is amplified and recorded as the polarization sign and magnitude. The d-c component of the signal from the phototube is recorded as the sky brightness signal.

The EOLM is driven with a 50-cps, 3,000-v signal from an oscillator and power amplifier. The output of the power amplifier, 78 V a-c, is fed to a step-up transformer near the EOLM.

The frequency of the driving signal is determined by a twin-T filter in a negative-feedback loop in the oscillator, Fig. 3. A small amount of the oscillator output from the plate of V_{2A} is coupled through R_1 to the plate of V_{2B} and appears at the cathode of V_{2B} and the grid of V_{1B}. Tube V_{1B} amplifies the signal and feeds it to the grid of V_{2A}. The varistor limits the amplitude of the signal and prevents V_{2A} from being cut off. This is the positive feedback loop. Tube V_{2B} acts only as a variable resistor.

The output is also fed through a twin-T filter and a phase-correction network to V_{1A}, which is cathode coupled to V_{1B}. When a signal at other than the null frequency of the twin-T filter appears at the output of the oscillator, it will pass through the twin-T filter to the grid of V_{1A} and be cathode-coupled to V_{1B}. This signal then cancels the unwanted signal in the positive feedback loop. At the null frequency, there is no negative feedback because the twin-T does not pass the null frequency of 50 cps, so the positive feedback will cause oscillation only at the null frequency of the twin-T filter. The oscillator output is coupled to V_3, a phase inverter which drives the push-pull output stage. Feedback from the output of the push-pull output stage optimizes the phase inverter balance and output wave form.

Part of the amplifier output is rectified by D_3 and D_4, filtered and applied to V_{2B} as amplitude control feedback. If the output increases, V_{2B}'s grid is driven negative. This increases the effective resistance of the tube, and the gain of the oscillator's positive feedback loop is decreased with a resulting decrease in the oscillator output. Potentiometers R_2 and R_3 determine the output of the driver; and R_4 provides an offset voltage for V_{2B}. Because of C_1 there is also a variable integration function present depending on the relative positions of R_2 and R_4. Potentiometer R_5 controls the amount of drive to the output stage and the gain of the amplitude control feedback loop. If the amplitude control feedback loop should fail, D_1 and D_2 will limit the output by clipping the driving signal for the output stage. The redundancy in amplitude limiting was included to protect the EOLM against accidental overvoltage.

Part of the driver output is coupled to a resistance-capacitance variable phase shift network (R_6 and C_2), to supply a reference signal for the synchronous detector.

The modulated signal from the phototube drives a cathode follower, V_{30}, which isolates the phototube and reduces the source impedance so that the signal may be carried by coaxial cable to the electronics portion of the instrument. The d-c component of the signal from V_{30}, which represents sky brightness, drives a 1-ma recorder. The leads to the recorder are shielded and isolated to prevent stray signals from being introduced in the system. Tube V_{32A} and R_7 provide a zero control for the recorder.

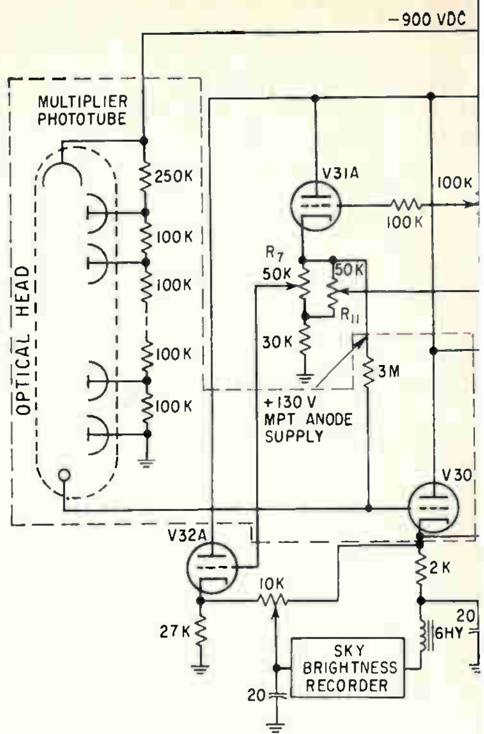
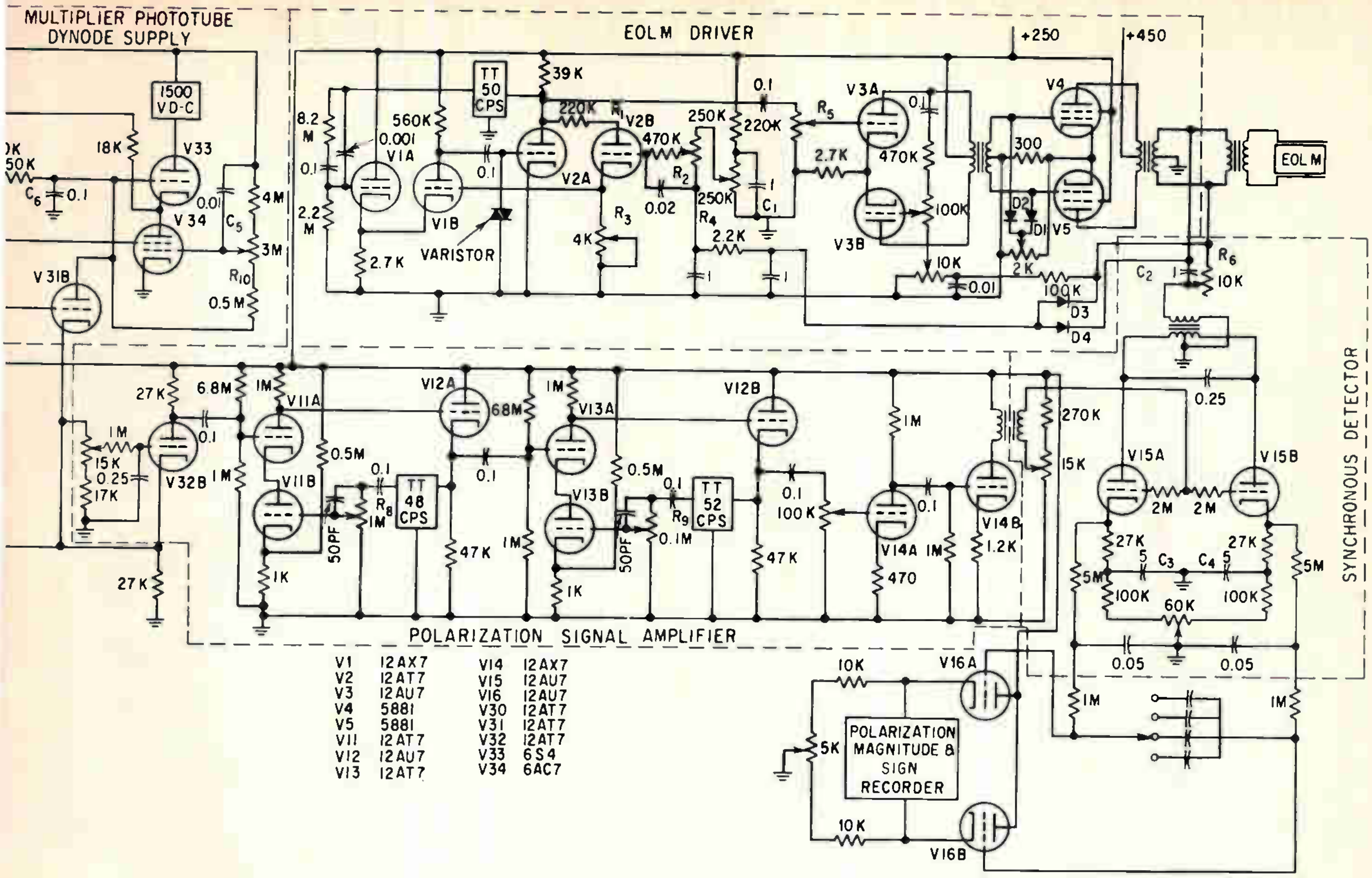


FIG. 3—Optical head with dynode supply, electro-optical light modulator driver amplifiers, polarization signal amplifier and synchronous detector

The signal from V_{30} is also cathode coupled to V_{32B}, which feeds the tuned amplifier. The signal-to-noise ratio could be improved by reducing the bandwidth of the system after the phototube. However, the tuned amplifier does not establish the bandwidth; its function is to reject stray singnals, primarily the 60-cycle powerline and its harmonics. The actual bandwidth of the system is established by the R-C filters that follow the synchronous detector. There are two stages of tuned amplification that use twin-T filters to maintain narrow bandwidth. One stage is staggered on each side of the 50-cps signal frequency by 2 cps to broaden the amplifier bandpass and to reduce phase shifts, which would occur if the signal frequency shifted slightly.

Each amplifier consists of a triode stage of voltage amplification, a cathode-follower output stage, and a triode in a frequency- selective negative feedback loop. The signal is amplified by V_{11A} and is direct coupled to cathode follower V_{12A}. Part of the output is coupled through a twin-T filter that has a transmission null at 48 cps. The



signal from the filter is resistance coupled to the grid of V_{11B}, which is cascode coupled to V_{11A}.

When a signal at null frequency appears at the output of the amplifier, none of the signal is passed by the twin-T filter. When a signal at other than null frequency appears at the output of the amplifier, part of it is passed by the twin-T filter and amplified by V_{11B}. Since V_{11B} is cascode coupled to V_{11A}, the unwanted signal is fed back in opposite phase, and its amplitude is reduced. Potentiometer R_8 controls the amount of negative feedback and therefore the bandwidth of the amplifier. Bandwidth is an inverse function of the gain of the feedback loop.

The second stage of amplification is identical to the first, except that the null frequency is 52 cps. By adjusting R_8 and R_9, the bandwidth can be optimized for minimum phase shift from 49 to 51 cps.

The signal from the output of the tuned amplifier is resistance coupled to V_{14A} and then to V_{14B}, two stages of voltage amplification. The output of V_{14B} is transformer coupled to V_{15B}, the synchronous detector. The synchronous detector compares the signal from the phototube with the phase-reference signal from the EOLM driver. The detector output then represents polarization sign and magnitude.

The reference phase is applied

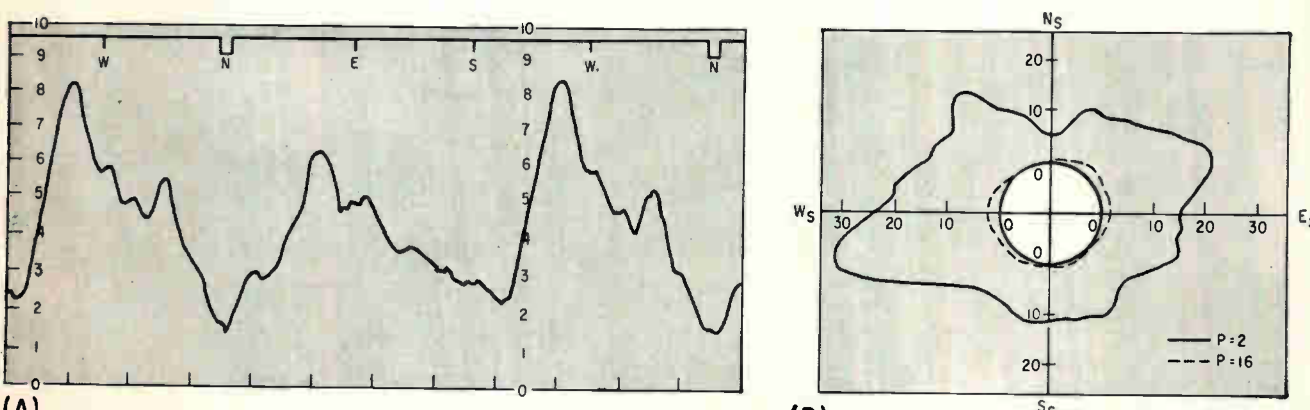


FIG. 4—Scan at 2 minutes of arc above the limb (A); letters at top indicate position angle on sun. Polar plot (B) of quality pB as function of position angle, for scans at 2 minutes and 16 minutes (one solar radius) above the limb. Unit is 4.1 × 10^{-8} of the radiance of the center of the solar disk at 5,200 angstroms

to the plates of the synchronous detector, V_{15}. When the plate of V_{15A} is positive with respect to ground, the plate of V_{15B} is negative. Therefore, V_{15A} is active, and V_{15B} is inactive. On the next half cycle of the reference phase the situation is reversed. Assume now that a small a-c signal is present at the grids of V_{15} in the proper phase relationship with the reference phase at the plates, and that this grid signal is in its positive half cycle while V_{15A} is active. Tube V_{15A} will now act like a cathode follower, and charge C_3 to a value determined by the normal resting level of the cathode follower plus the small voltage present at the grid. On the next half cycle, V_{15B} is active, but now the signal at the grid is in the negative part of its cycle, and V_{15B} will charge C_4 to the value determined by normal resting level of the cathode follower, minus the small voltage present at the grid. The output from the synchronous detector is the difference in charge on C_3 and C_4. This difference is roughly equal to the amplitude of the a-c signal, providing that the a-c component is small with respect to the normal resting voltages for the cathodes of V_{15}.

This difference voltage is passed through an r-c time constant, made variable by switching different capacitors between the grids of V_{16}. The bandwidth of the instrument is established here. The setting of the bandwidth nearly always involves a compromise. It is desirable to have the time constant long enough to smooth most of the fluctuation noise from the phototube; however, airborne seeds, dust, and bugs drifting in front of the instrument cause short-duration, high-amplitude bursts of polarization. To keep the effects of these from lingering too long, the time constant should be kept short.

The high voltage for the phototube is regulated and also controlled to prevent damage if too much light enters. This can happen if improper pointing of the telescope should let direct light from the solar disk into the K-coronameter. The output of the high-voltage regulator is set by R_{10}, which determines the ratio of the output voltage to the reference voltage. The grid of V_{33} is referenced to 176 v and the V_{34} screen is referenced to 88 v, from 5651 voltage reference tubes. The regulator controls by maintaining the ratio of voltages $E_{ref}/E_{out} = R_{ref}/R_{out}$, where E_{ref} is the reference voltage at the grid of the V_{33}, E_{out} is the output voltage, R_{ref} is the resistance from grid of V_{34} to grid of V_{33} and R_{out} is the resistance from the grid of V_{34} to the output. The voltage at the grid of V_{34} is approximately at ground, a condition imposed by the feedback loop. If the output voltage increases, the grid of V_{34} will go negative. This change is amplified by V_{34} and cathode-coupled to V_{33}, which conducts less and reduces the output voltage. Capacitor C_5 increases sensitivity to fast changes in the output voltage and aids stabilization of the feedback loop.

Tube V_{31B} is the override control to protect the multiplier phototube from too much light. It is cathode coupled to V_{30}, the phototube cathode follower. Tube V_{31B} is normally biased to cut-off. When a large amount of light strikes the phototube, its anode voltage decreases, the cathode voltage of V_{30} decreases and V_{31B} conducts, reducing the reference voltage for the high-voltage regulator. The voltage to the phototube is then reduced proportionately and eliminates the possibility of damage. Capacitor C_6 reduces sensitivity to high-frequency noise from the phototube and consequently, erratic regulation. Potentiometer R_{11} adjusts the level at which V_{31B} will conduct; it is adjusted so that normal operation around the limb of the sun will not activate the protection circuit.

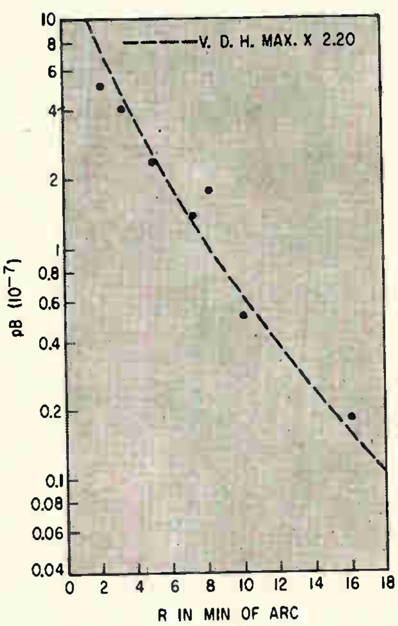


FIG. 5—Variation of pB with height above the limb for quiet sun, excluding polar regions

Figure 4A shows a tracing made from the polarization recorder on a scan near the sun; Fig. 4B shows a polar plot of data near the sun, and another approximately one solar radius from the limb. The recorded quantity is pB, where p is the polarization (a number between 0 and 1), and B is the radiance of the corona. The instrument cannot tell the difference between a weak source strongly polarized, or a strong source weakly polarized. This must be determined in the data reduction program, utilizing knowledge of the scattering angles.

Figure 5 shows the variation of the quantity pB as a function of height above the solar limb.

The data reduction program under way has the following objectives:

(1) Determine the real electron densities in the corona (3 dimensional).

(2) Develop statistics of coronal activity and extend this through the 11-year solar cycle.

(3) Find out if there is a relation between the positions of coronal streamers and magnetic storms on the earth.

The development of the K-coronameter was supported by the Institute of Solar-Terrestrial Research and the U. S. National Committee for the IGY (through a grant from the National Science Foundation). Additional support was also given by the Radio Corporation of America.

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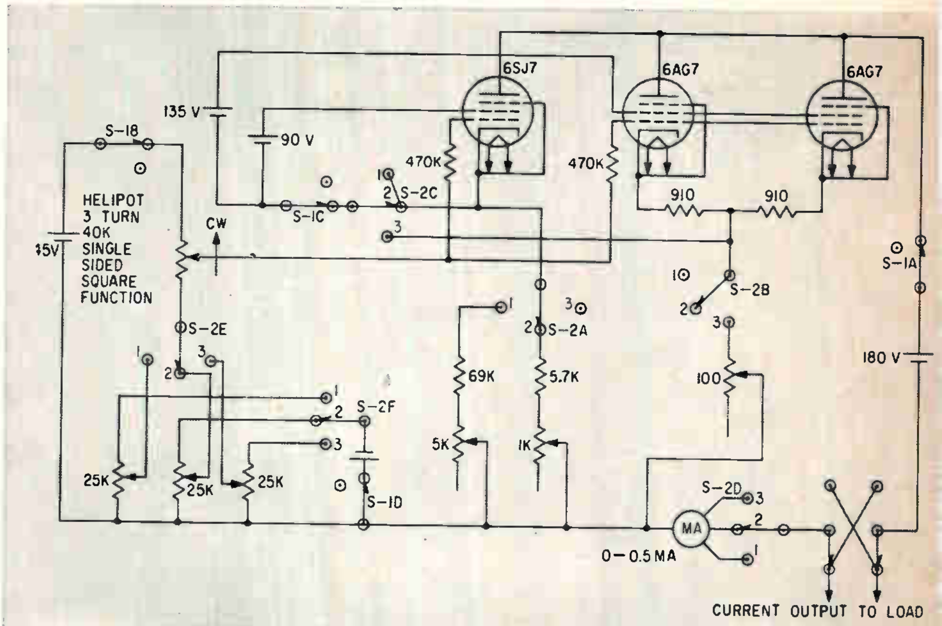
Constant-Current Generator

MEASURES SEMICONDUCTOR RESISTANCE

Isolated constant-current generator reduces the time required to obtain resistivity profiles. High accuracy is obtained by reading current from dial settings instead of meters

By PAUL J. OLSHEFSKI
Control Associate, Merck & Co., Inc.
Danville, Pa.



Current range of this constant-current generator is selected by switch S_1. Helipot is set to read diameter of the sample

RESISTIVITY of semiconductor compounds is a fundamental variable in the design of semiconductor devices. Rapid and precise measurements are made possible by a constant-current generator designed for this purpose.

In evaluating float-zone refined single crystals, a two-point probe is suited for quality-control measurements. If the current is adjusted in proportion to the area, resistivity is directly related to the voltage drop between probes. The ease and accuracy of this setting are the important features of this generator. The figure is a schematic of the unit.

The generator uses the flat portion of the plate voltage-current relationship of a pentode to supply a constant current to the sample. Magnitude of the current is controlled by varying grid bias. A large amount of negative feedback is employed in the cathode to keep the plate current linear with grid voltage over a wide range.

Currents of 0.5, 5 and 50 ma can be supplied to the sample. For the two low ranges, one type 6SJ7 tube is used; to obtain the higher output current, two type 6AG7's are placed in parallel. Since the high range would normally be used in testing low resistivity samples, the reduced effective plate resistance of the circuit presents no problems in maintaining constant output currents with variations in load resistance.

Proper operation of the circuit calls for a well-regulated screen supply. On the low ranges, the negative side of this supply is tied directly to the cathode and is unaffected by changes in plate current. On the high output ranges, separate cathode resistors are used and the screen supply is returned to this common point. This arrangement obviates the use of balanced tubes with little sacrifice in stability.

With a floating output and complete isolation from ground, this generator is useful with line-operated voltmeters. The possibility of ground loops is eliminated.

To avoid calculating the area of each sample, the magnitude of the current is controlled by a single-sided square-law Helipot placed in the control-grid circuit. By biasing the tube so that the projection of the i_b vs e_c characteristic passes through the origin, the turns-counting dial reads diameter directly. In practice, if the crystal has a diameter of 2.4 cm, the dial is adjusted to 2.4. The output current is 4.52 ma corresponding to a crystal area of 4.52 sq cm.

The circuit was originally designed to track throughout the range with an accuracy of ±2 percent. Since the normal diameter specifications of float-zone-refined single crystals falls between 1.8 and 2.5 cm, this portion of the range can be calibrated to track with less than ±1 percent error.

For the two-point probe measurement, with probe spacing set at 1 cm, the measured voltage drop is equal to resistivity. The circuit can also be modified for use with a four-point probe.

The author acknowledges the contributions of R. H. Young, Prof. of Electrical Engineering, Bucknell University, Lewisburg, Pa.

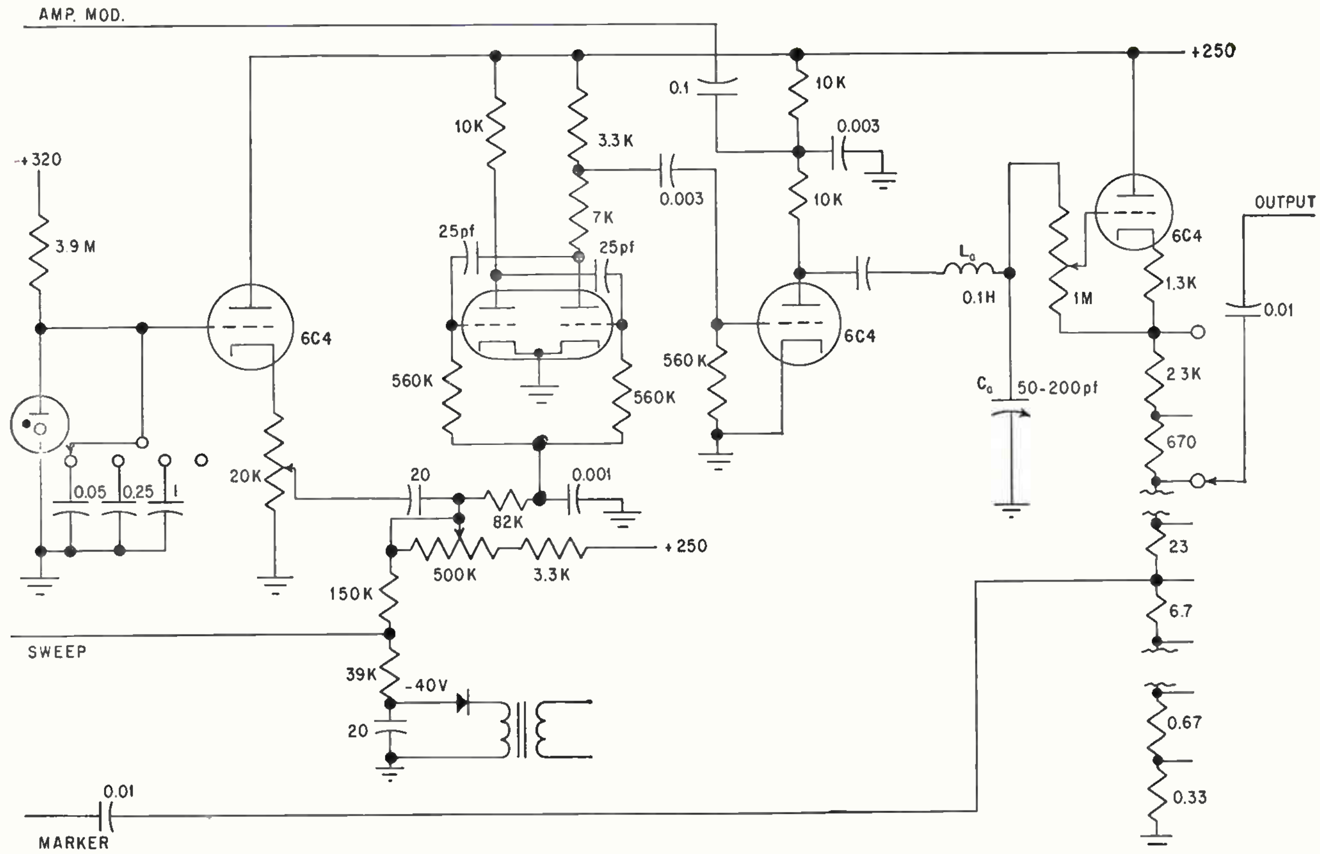
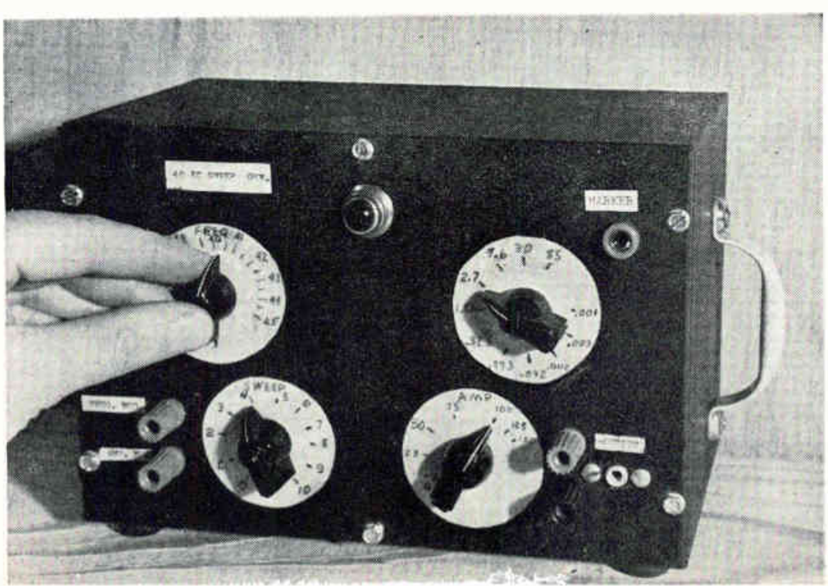


FIG. 1—Grid-controlled multivibrator circuit has sweep of 0 to 7 Kc, with center frequency adjustable from 36 to 44 Kc. Maximum output voltage is 85 volts peak-to-peak. Neon-tube sweep generator operates at 1, 6 and 22 cps

Sweep Generator Tests Ultrasonic Remote Controls

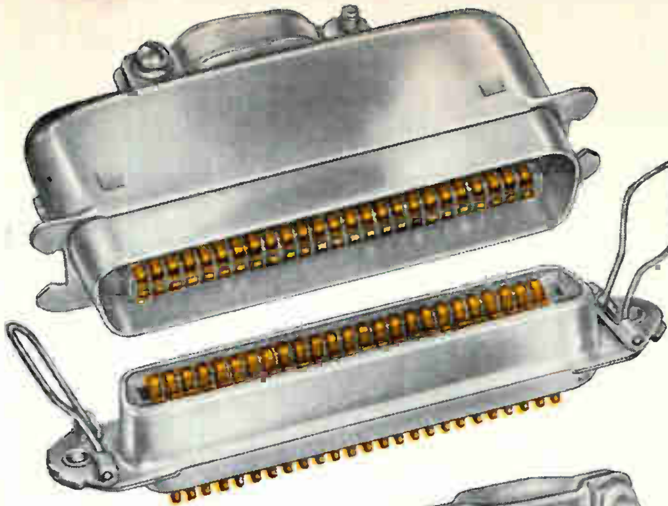
Prototype sweep generator is useful for testing ultrasonic remote control units and systems



By GEORGE ROW
Rowco Engineering Co.,
Indianapolis, Indiana

SWEEP GENERATORS are used by the tv industry for design and production testing of both front-ends and i-f strips. Unfortunately the units available on the market are not serviceable at the low frequencies used by ultrasonic remote control systems. A prototype generator for this application is shown in the photograph; this instrument has proven satisfactory and useful.

The heart of the sweep generator is a 6J6 in a conventional multivibrator. Frequency is controlled 'he smooth, easy insertion and extraction ıction, the self-wiping, self cleaning features and the double-sided, flexing action ıf both mating contact members make Aicro-Ribbons the first miniature connectors o provide reduction in size with added eliability.



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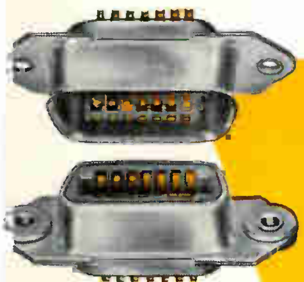
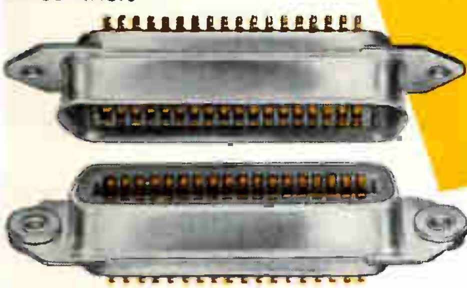
The compact housings are equipped with sturdy spring type latches on the receptacles which are guided and held by cut-outs in the plug flanges.

Receptacle shells have floating bushings allowing a float of .020 in each direction.

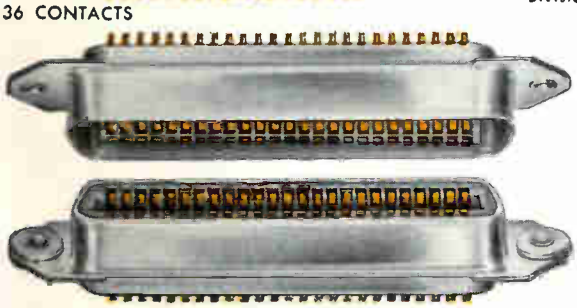


4 CONTACTS

24 CONTACTS

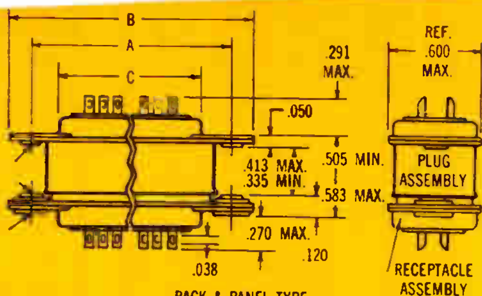


36 CONTACTS



50 CONTACTS

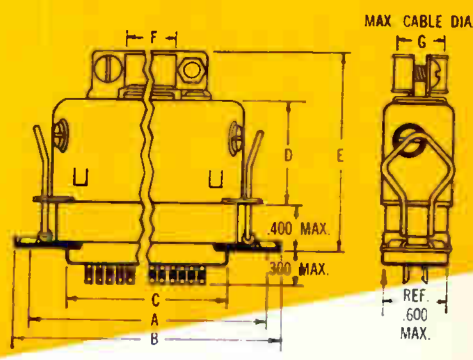
RACK AND PANEL TYPES



RACK & PANEL TYPE

DIMENSIONS

		14 Contacts	24 Contacts	36 Contacts	50 Contacts
BOTH TYPES	A	1.417	1.842	2.352	2.947
	B	1.750 REF.	2.175 REF.	2.685 REF.	3.280 REF.
	C	.910 REF.	1.335 REF.	1.845 REF.	2.440 REF.
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668 MAX.	1.668 MAX.	1.730 MAX.	1.825 MAX.
	F	.306 MAX.	.473 MAX.	.640 MAX.	.766 MAX.
	G	.422 MAX.	.473 MAX.	.473 MAX.	.473 MAX.



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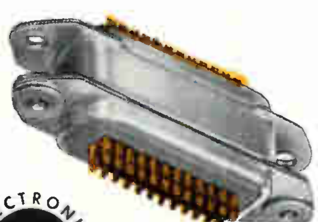

RACK AND PANEL CODE NOS.

CONTACTS	PLUG	SOCKET
14	57-10140	57-20140
24	57-10240	57-20240
36	57-10360	57-20360
50	57-10500	57-20500

CABLE-TO-CHASSIS CODE NOS.

	PLUG WITH CAP	SOCKET WITH LOCK
14	57-30140	57-40140
24	57-30240	57-40240
36	57-30360	57-40360
50	57-30500	57-40500

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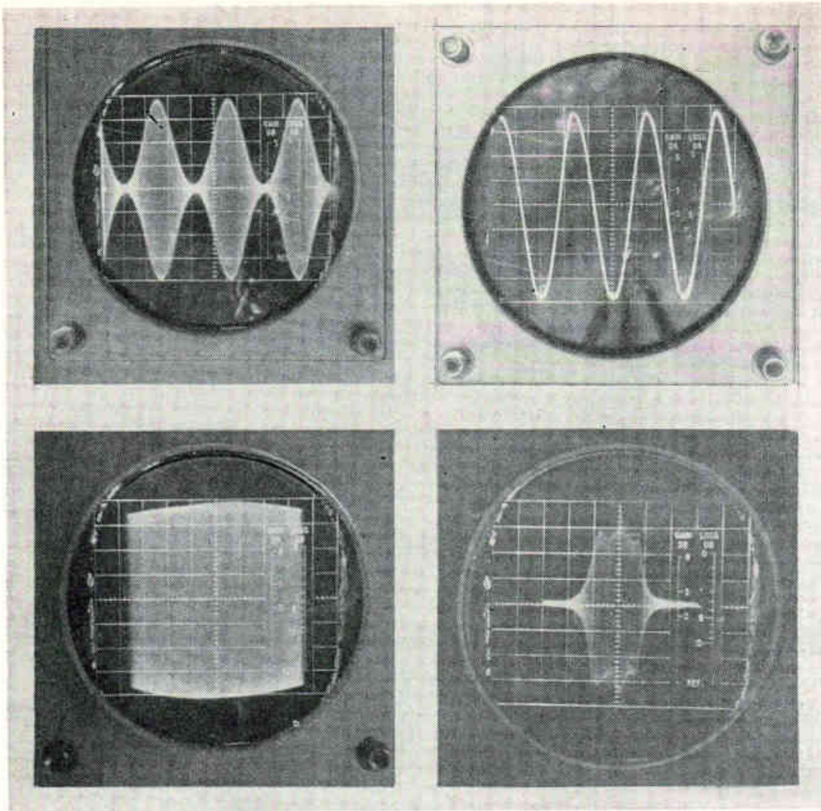

FIG. 2—Plate-modulated amplifier provides excellent linearity to 90-percent modulation, top left. Output waveshape, top right, approximates a sine wave sufficiently well for most applications. Single-tuned filter circuit permits some drop in signal amplitude at ends of sweep, lower left. Bandwidth of 2 Kc is indicated by response curve, lower right, obtained during test of a 40-Kc amplifier

by varying the grid return potential, providing good linearity between frequency and voltage.

A portion of the square wave developed by the 6J6 (see schematic) is fed to the following 6C4; the 6C4 is an amplitude modulator and buffer between the oscillator circuit and the waveshaping circuit that follows. A modulation transformer would reduce the amount of modulating power required but no transformer with the exact requirements was found commercially available. The resistance network in the plate circuit requires more power but provides excellent linearity of modulation, as shown in Fig. 2, (upper left).

Wave-shaping circuit L_a-C_a, tuned to 40 Kc, converts the square wave at the plate of the modulator to a sine wave as shown in Fig. 2B. The circuit Q (using readily available components) is sufficiently low that bandwidth is adequate. Note from Fig. 2, (lower left) that drop in signal amplitude is about 0.5 db at 36 and 44 Kc. A flatter response at some expense in waveform could be obtained by shunting L_a with a resistor. A preferable solution would be an overcoupled double-tuned transformer.

The output section, consisting of a cathode follower driving a voltage divider, has been found adequate for the application. However, an attenuator would improve the utility of the instrument. Provision is made for coupling an external marker signal into the voltage divider. The connection is to a low point on the divider because coupling to a higher point permitted the marker terminal to inject signals into the sensitive circuits under test.

A sawtooth sweep signal of approximately 40 volts is provided by the neon-tube relaxation oscillator shown at the left of Fig. 1. The neon tube also doubles as a pilot light, and is shown in the photograph. The three capacitors in the relaxation oscillator circuit provide a choice of sweep frequencies.

A low-frequency sawtooth sweep (1, 6 or 22 cps) is provided as an alternative to sweeping with the 60-cycle line voltage. Experience in testing tuned circuits in the 40-Kc range revealed that many of the circuit Q's were sufficiently high that a 60-cycle sweep could not be followed. Circuit response curves were highly distorted. Consequently the sweep circuit used in Fig. 1 was designed; the resultant generator has proved satisfactory in all tests conducted thus far. Figure 2, (lower right) shows a typical response curve obtained during test of an amplifier.

The high Q's of the circuits under test give rise to still another trouble. The marker pip is lost in a normal response curve. The beat frequency will appear in the skirt of the response curve but no pip will appear in the high portion of the curve. This again is due to the inability of the circuit under test to dissipate energy rapidly. Consequently it is necessary to calibrate the trace by feeding the generator output signal directly to the oscilloscope. Sweep width, center frequency, and horizontal gain are adjusted to cause the grid lines to fall on integral frequencies.

The low sweep frequencies make it necessary to use an oscilloscope with a d-c horizontal amplifier. To facilitate the use of d-c amplification, the sweep signal taken from the generator has zero d-c component with respect to ground. As shown in Fig. 1, this is accomplished by taking the sweep signal from a voltage divider, the bottom of which is at −40 volts.

Experience with the instrument has shown that the stability of the 6J6 multivibrator and attendant circuits is such that the external marker need seldom be used. The oscilloscope may be calibrated by reducing the sweep width to zero and using the generator center frequency control to calibrate.

The dial plates of the prototype unit appearing in the photograph consist of sandblasted plastic sheet glued to white cardboard, which in turn is glued to the cabinet. Dial markings are made with pencil and can be erased. Power is applied through a tv interlock installed in the rear of the cabinet, eliminating the conventional dangling line cord that is bothersome when equipment is moved.

Analog Computer Error Source Is Identified

By R. D. KRAUS,
Senior Staff Engineer
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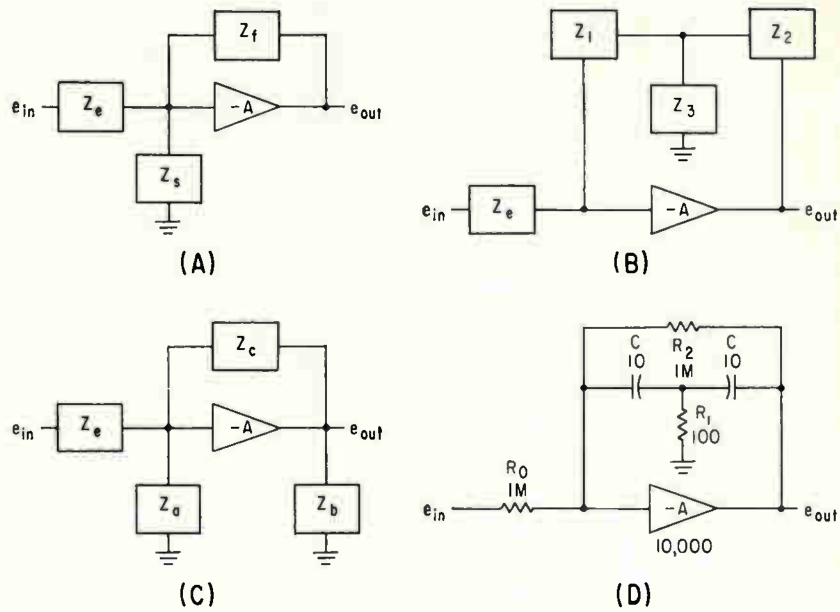
Scottsdale, Ariz.



Basic feed back amplifier is shown at (A). Circuit at (B) can be transformed to that at (C). Example (D) shows possible magnitude of error

IDENTIFICATION of the origin of a large error sometimes encountered in using analog computers permits it to be avoided or compensated. This significant difference between expected and actual results has occasionally been observed in synthesizing transfer functions with feedback amplifiers. Although it is a function of amplifier gain, it is considerably larger than the error predicted by error-factor formulas.

The error arises when high gain is required at some frequency and a three-terminal network is used in the feedback loop. For example, these conditions might occur in synthesizing a highly resonant single-degree-of-freedom mechanical system using computer networks rather than a series of integrators.

When accuracy is not too important, desired frequency responses are occasionally obtained with amplifiers having open-circuit gains of several hundred. However, computer amplifier gains of 10,000 and 20,000 are common, and they are expected to provide accuracies better than ½ percent. In the example described later, actual output was 34 percent less than predicted. With an amplifier gain of 10,000, the predicted error using published error-factor formulas is only ½ percent.

In the feedback amplifier at A in the figure, neglecting the effect of output loading, transfer function is

$$E_{out}/E_{in} = -(Z_f/Z_e)/\{1 + (1/A)[(Z_f/Z_e) + (Z_f/Z_s) + 1]\}.$$

For a three-terminal network, Z_f is defined as short-circuit transfer impedance or the ratio of applied voltage to short-circuit current, and Z_s is input impedance at the summing point.

The term Z_f/Z_s is an error term. However, this term is frequently neglected because input impedance is usually assumed to be high.

The circuit at B can be transformed to that at C using T − π or Y delta transformation. At C,

$$Z_a = (Z_1Z_2 + Z_1Z_3 + Z_2Z_3)/Z_2,$$
$$Z_b = (Z_1Z_2 + Z_1Z_3 + Z_2Z_3)/Z_1 \text{ and}$$
$$Z_c = (Z_1Z_2 + Z_1Z_3 + Z_2Z_3)/Z_3.$$

Since only open-circuit gain and operating range are affected by loading, its effect is usually small and Z_b will be neglected. Short-circuit transfer impedance Z_c is listed in tables, and the Y delta transformation provides a simple way of deriving this function.

The term Z_a is pseudo amplifier input impedance, and the error produced by such an impedance is Z_c/Z_a. For a T network, this error is Z_2/Z_3. This conclusion can be confirmed by nodal analysis of the network.

In part D of the figure, transfer impedance function as given in tables is

$$Z_f = R_2 (1 + pT_1)/(1 + pT_1 + p^2T_1T_2),$$

where $T_1 = 2R_1C = 0.002$ and $T_2 = R_2C/2 = 5$. The computer transfer function is then

$$Z_f/Z_e = (R_2/R_o)[(1+pT_1)/(1+pT_1+p^2T_1T_2)] = (1+j0.02)/j0.02 = |50|$$

at $p = j10$ radians per second. The error factor usually considered is

$$EF = 1/[1 + (1/A)(1 + Z_f/Z_e)],$$

which is equal to 0.9949 or ½ percent at $p = j10$.

The actual error and transfer impedance function Z_f can be computed readily using a Y delta transformation:

$$Z_a = (1/pC) + 2R_1 = (1+pT_1)/pC \text{ and}$$
$$Z_c = (1/p^2C^2R_1) + (2/pC) = (1+pT_1)/(p^2C^2R_1).$$

Transfer impedance function Z_f is the parallel combination of R_2 and Z_c, which is

$$[(1+pT_1)/p^2C^2R_1]\,R_2/[(1+pT_1)/p^2C^2R_1 + R_2] = [R_2(1+pT_1)]/(1+pT_1+p^2T_1T_2),$$

as previously used. The error factor is

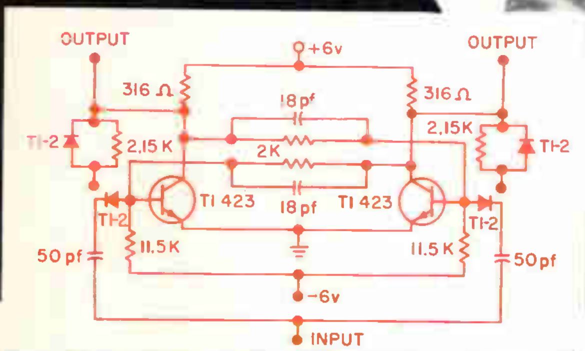
$$EF = 1/[1+(1/A)(1+Z_f/Z_e+Z_f/Z_a)] \text{ or}$$
$$EF = 1/\{[1+(1/A)][1+(R_2/R_o)(1+pT_1)/(1+pT_1+p^2T_1T_2) + 2T_2p/(1+pT_1+p^2T_1T_2)]\}.$$

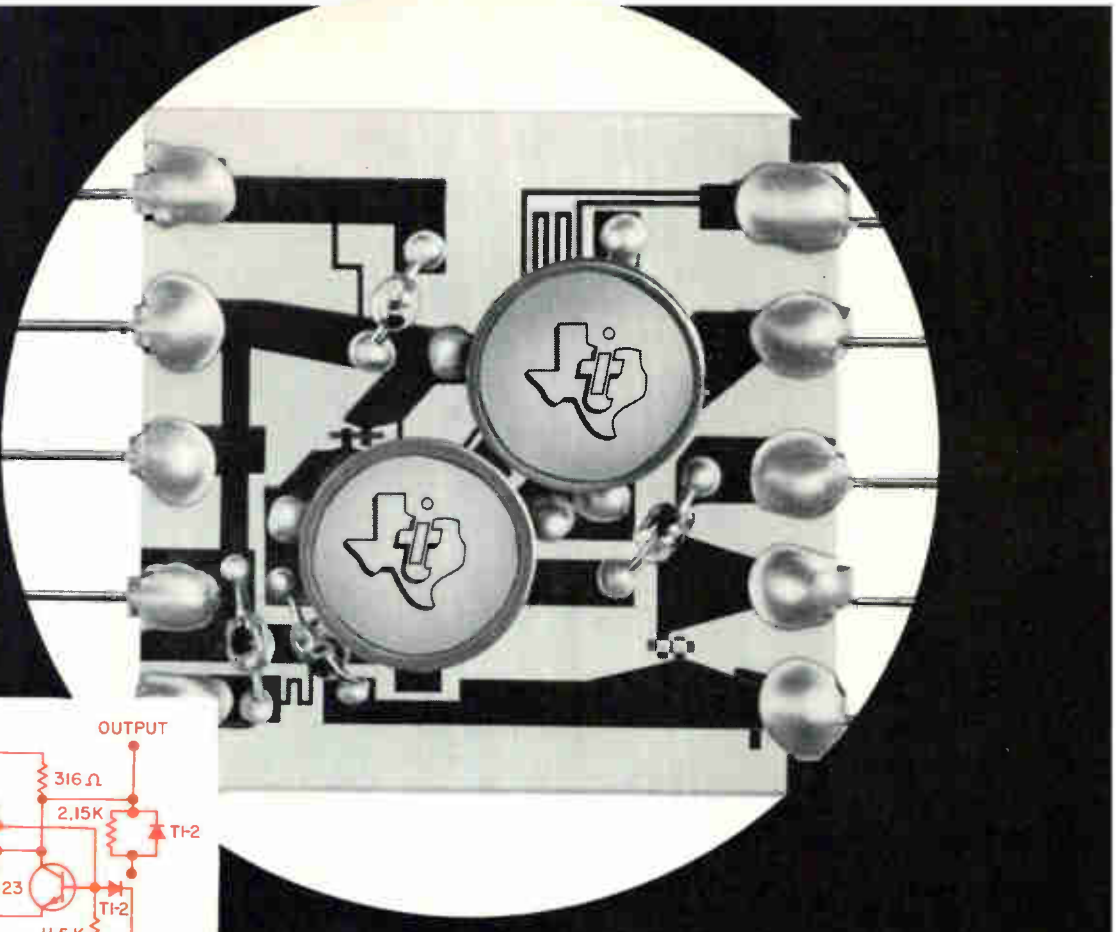
At $p = j10$, a resonant point ($p^2T_1T_2 = -1$), the error factor becomes

$$1/\{[1+(1/A)][1+(1+pT_1)/pT_1]\,R_2 + 2T_2/T_1\} = 0.667.$$

Net gain is then $50 \times 0.667 = 33.3$.

To confirm this analysis, the circuit was set up on an analog computer with a measured open-circuit gain of 10,000 at 10 radians per





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SPERRY ELECTRONIC TUBE DIVISION **microwave memo**

Sperry adds high-power pulsed TWT's to list of tubes available in 30 days

In a move to simplify design problems in present and future radar systems, Sperry Electronic Tube Division of Sperry Rand Corporation has added two high-power pulsed traveling wave tubes to the list of advanced microwave tubes available in 30 days.

The two tubes covered by the announcement—the STL-114 and the STC-152—operate in L and C bands, respectively. They are typical of a line of pulsed TWT's ranging from P through V bands which Sperry offers on a firm delivery date basis.

EASY RADAR APPLICATION

Sperry's pulsed TWT's are admirably suited to the demands of application in phased array radars, height finders, search, ECM, and other radar applications. Widely varied in-system experience has proved that their reliability, long life, high power, high gain, and extreme broadband operation make them ideal for radar use.

Design features of this tube family minimize the necessity for system adjustments in the field. Among these features are broadband response, constant voltage operation, and short circuit stability.

VERIFIED RELIABILITY

These pulsed TWT's, produced at Sperry's Great Neck, N. Y., facility, have compiled an impressive record of in-system experience. Such experience has proved that their resistance to shock and vibration damage, their inherent indifference to ambient conditions, and their mounting flexibility make them ideal for ground or airborne application.

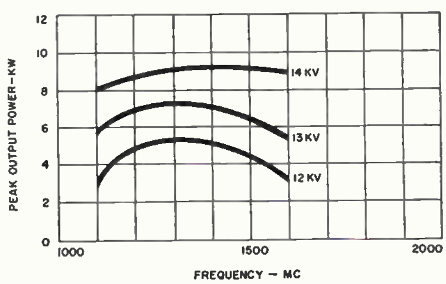
Place your order with your Cain & Company representative. His phone number appears in the adjacent column. Tubes are available within 30 days after receipt of order.

FREE TECHNICAL INFORMATION on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 304, Sperry Electronic Tube Division, Gainesville, Florida.

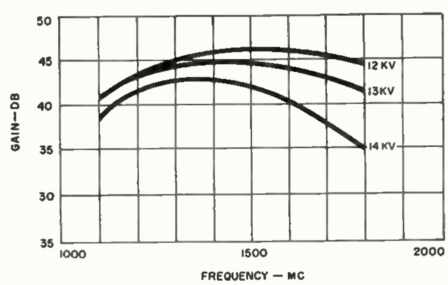
V BAND CAPABILITY

Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band —26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.

FACTORY ALIGNMENT of a Sperry TWT within its focusing solenoid greatly simplifies field maintenance. Once this operation has been performed by a skilled Sperry technician, the assembly is self-aligning.



Typical saturated power output vs. frequency for a pulsed Sperry TWT.



Typical small signal gain vs. frequency for a pulsed Sperry TWT.

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

second. Maximum gain obtained at resonance was 33 and not 50 as had been indicated by the simplified formulas.

Mixer Circuit Lowers Radiotelephone Costs

By M. E. BAIRD*
Burlingame, Calif.

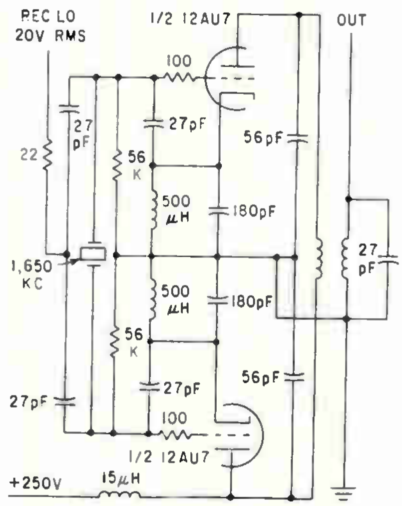
TRANSMITTER mixer circuit has been developed that requires only one crystal per channel in 27-Mc citizens band radiotelephones. The arrangement reduces costs compared to the conventional channel-selection method requiring two crystal for each channel.

The functions of both beating oscillator and balanced mixer are combined in the circuit shown in the figure. The receiver local oscillator signal and even harmonics of the beating oscillator frequency are canceled in the tuned symmetrical plate circuit. The selectivity provided by the two tuned circuits attenuates odd harmonics of the beating oscillator frequency and the undesired mixer product. Spurious frequency components of the transmitted signal are down at least 55 db.

Parasitic oscillations occurred when the transmitter was first operated, which inhibited starting of the beating oscillator crystal. This problem was overcome by adding the small resistors shown in the diagram in the grid leads and in the line to the receiver local oscillator. When drive from the receiver local oscillator exceeded 30 volts, the resulting high rectified grid bias also tended to prevent the crystal from starting.

The circuit provides an unexpected and desirable byproduct. The high initial drift in frequency sometimes encountered with citizens band transmitters has been eliminated. Stability is improved because the receiver local oscillator operates continuously and initial drift is negligible at its low frequency.

*Author was employed at Raytheon Marine Products Operation when circuit was developed



Mixer circuit requires only one crystal for each radiotelephone channel

Tachometers Measure Missile Model Spin

PHOTOTRANSISTOR tachometers are measuring spin rates and spin decay rates of miniature missile models revolving in a supersonic wind tunnel. The relatively inexpensive tachometers are accurate at speeds as slow as two revolutions per second.

The tachometers were needed to collect data on the aerodynamic stability of missile configurations. They were invented by C. F. Miller at the U. S. Naval Ordnance Laboratory in Silver Spring, Mo.

In two versions of the new tachometer, the components are small enough to be mounted inside the missile model. In three other variations, components are mounted both inside the missile model and on the sting mount that supports the model during tests.

Basically all variations of the tachometer consist of a light source, a phototransistor and a perforated wheel or similar device for interrupting the beam from the source to the phototransistor. By attaching the perforated wheel to the tail of the revolving missile model, the light pulses change resistance of the phototransistor at a rate proportional to missile rotational velocity. The resistance changes provide electrical signals that are counted per unit of time to determine spin rate or spin damping rate.

Phototransistor tachometers provide better signal to noise ratio than the electromagnetic tachometers.

New ion-exchange cell, the size of a quarter, (left) produces slightly less than 1 volt and up to 100 amperes per sq ft. A number of these cells in series will power space equipment, telemetry devices, and portable ground communications, with efficiencies of 90 per cent. Inventors Dravnieks and Bregman (right) check voltages on experimental apparatus used during successful testing of the inorganic membrane

Fuel Cell Obtains High Efficiency

A WAFER-TYPE fuel cell which can supply electrical power in the high temperature and radiation environment of outer space has been developed by the Armour Research Foundation of Illinois Institute of Technology.

Using hydrogen and oxygen for fuel, the cell is composed of an inorganic ion-exchanging membrane which operates at higher temperatures than the organic types now in use, according to Jack Bregman, supervisor of physical chemistry research, and Andrew Dravnieks, ARF scientific advisor.

The stability of organic membranes drops off sharply at 70 deg C while increased power can be attained at 100 deg C with the inorganic material. The inorganic cell is more resistant to radiation of a nuclear or cosmic origin.

Described as a breakthrough development, the new fuel cell offers an unusually high energy-to-weight ratio, whereby efficiencies are almost unlimited.

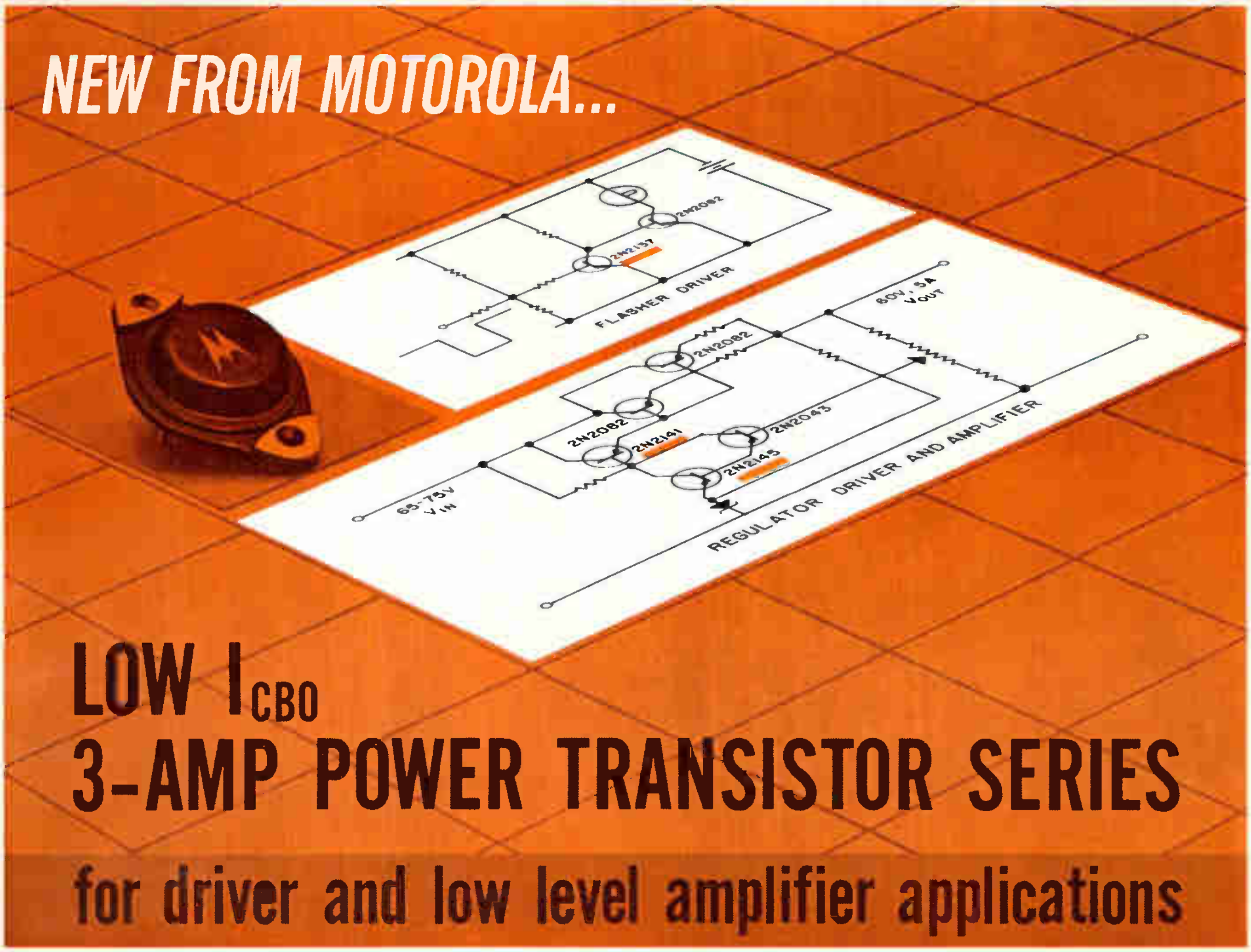
Explaining the significance of the development, Bregman and Dravnieks pointed out that inorganic materials do not require water to maintain stability, thus resulting in a lighter cell for space applications. On the other hand, organics require liquids to maintain pliancy in the membrane, which adds excess weight to be boosted into outer space.

Foundation scientists have produced experimental cells about the size of a quarter, which have produced 0.95 volt over an open circuit. The inorganic membrane can attain up to 100 amperes per sq ft, while the organic cell attains only about 35 amperes, according to the co-inventors.

As explained by the inventors, hydrogen causes a reaction on one side of the membrane which gives off electrons. Oxygen on the second side creates a void in electrons, and when hydrogen ions traveling through the membrane complete the circuit, a flow of electrons take place from the anode (surplus electrons) to the cathode (electron deficit), thus completing the electrochemical reaction.

With any number of the wafer-type cells arranged in series, sufficient voltages may be derived to supply the necessary power for satellite communications, telemetry devices in space, and for operation of equipments during future manned landing on the moon and other planets, the scientists stated.

Other applications for the new fuel cell would be to supply power packs for foot soldiers. Its light



LOW I_{CBO}
3-AMP POWER TRANSISTOR SERIES
for driver and low level amplifier applications

Motorola's new 3-amp power transistor series, the 2N2137-46, offers I_{CBO} (at 2 volts) of only 50 μA instead of the usual 200 μA. Also the thermal resistance of the new small junction devices has been reduced to 1.2°C/W instead of the usual values of 1.5 to 2.5°C/W previously associated with such units. This results in a power dissipation rating of 62.5 watts at 25°C instead of the 35 watts you may be getting out of your present devices.

These new Motorola units are ideal as drivers for such types as the 2N2082 as illustrated in the accompanying circuit diagram. They are also superior in such applications as the direct-coupled amplifier circuit shown above.

The new devices are more completely specified . . . are available in "A" versions with complete life test data under Motorola's exclusive Meg-A-Life program . . . and they are available now at lower prices than comparable old-type units.

For complete specifications on the standard 2N2137-46 series, or the "A" versions available under the Meg-A-Life program, contact your Motorola district office, or call or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

MOTOROLA DISTRICT OFFICES:
Belmont, Mass. / Burlingame, Calif. / Chicago / Clifton, N. J. / Dallas Dayton / Detroit / Glenside, Pa. / Hollywood / Minneapolis / Orlando, Fla. / Phoenix / Silver Spring, Md. / Syracuse / Toronto, Canada.

Pick the device for your application from this new 2N2137-46 Series Box Selection Chart.

	h_{FE} @ 2V and I_C of 0.5A/2.0A	
	30-60/15 min	50-100/25 min
BV_{CES} 90V BV_{CBO} 90V BV_{CEO} 65V BV_{EBO} 45V	2N2141	2N2146
BV_{CES} 75V BV_{CBO} 75V BV_{CEO} 60V BV_{EBO} 40V	2N2140	2N2145
BV_{CES} 60V BV_{CBO} 60V BV_{CEO} 45V BV_{EBO} 30V	2N2139	2N2144
BV_{CES} 45V BV_{CBO} 45V BV_{CEO} 30V BV_{EBO} 25V	2N2138	2N2143
BV_{CES} 30V BV_{CBO} 30V BV_{CEO} 20V BV_{EBO} 15V	2N2137	2N2142

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HOW TO GET THE POWER TRANSISTORS YOU NEED?

JUST ASK DELCO. For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office—and ask for them.

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Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

DELCO RADIO

Division of
General Motors
Kokomo, Indiana

weight composition make it ideal for portable communications equipment, and its high energy-to-weight ratio would supply sufficient power for portable radar.

Although developed specifically for fuel cell application, the inorganic ion-exchanging membrane can do an efficient job in the desalinization of water.

New Method To Produce Ceramics Holds Promise

AN IMPROVED method of manufacturing high-purity ceramics for electronic applications appears likely to be developed through a current Air Force research project. An interim report describing the first five months of work in this research is now available.[1]

The production process, a direct metathetical precipitation of tetragonal barium titanate powder which is a variation of Flaschen's work with metallo-organics, was used to produce 99.95 percent $BaTiO_3$ in prepilot plant lots.

A pilot plant was designed which it is believed will now be capable of producing 25-pound lots. Comparison analyses of commercial materials and those produced in this study show improvements in purity and reproducibility.

It is felt that the successful results in the scaleup operations show that this process is capable of producing uniform, high purity ceramics. The pilot plant is versatile enough to produce, as well as titanates, compounds of zirconate, niobate, and tantalate groups with equal purities.

Components produced from materials prepared by this technique should be highly reproducible, resulting in savings of material and time.

The Office of Technical Services announced expanded distribution of similar interim reports.

REFERENCE

(1) Interim Report, Development of Manufacturing Processes for High-Purity Ceramics, International Telephone and Telegraph Corp., for U. S. Air Force, Phase I, Feb. 6 to July 6, 1961, OTS U. S. Dept. of Commerce Report AD 260 273, Washington, D. C.

Eyeing Growing Market for Photocells

These cadmium sulfide photoconductive cells were developed by General Electric. Company noted that market for these cells had tripled in the past year to 18 months, and predict continued growth next year. Devices are available in four basic sizes. The two small cells have metal-to-glass construction. Uses: from camera aperature controls to street lighting, to toys, anywhere a light-dependent control is needed (see ELECTRONICS, *p 74, Aug 5, 1960; and p 66, Dec. 23, 1960*

Comparison Method Speeds Potentiometer Tests

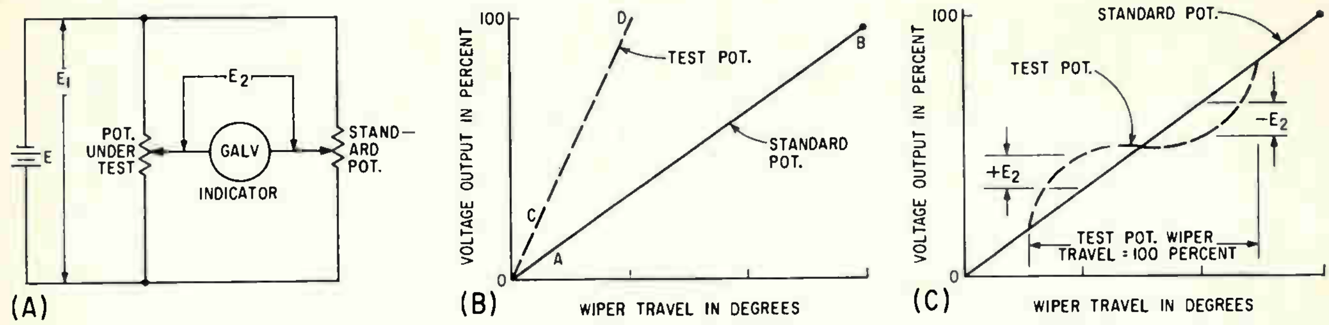


FIG. 1—Basic comparison circuit (A) is conventional bridge. Calibration curves of potentiometers with different amounts of active length (B) can be made to coincide over the range of interest (C) by gear train

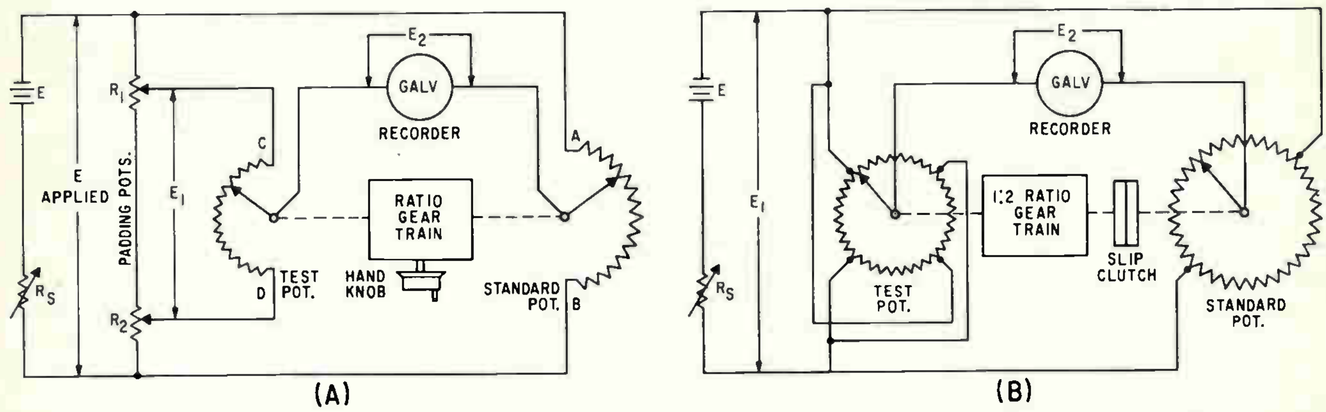


FIG. 2—Small arc potentiometers are geared to track with standard potentiometer (A). Closed loop potentiometers can be tested by circuit in (B)

By J. W. FULTON,
Western Electric Co.,
Winston Salem, North Carolina

WIDE USE of small wirewound potentiometers as data pickoffs in flight instruments has created a demand for a fast and accurate linearity test. Comparing the potentiometer under test to a standard potentiometer gives a fast, accurate, linearity test that also allows a permanent record of results. The potentiometer under test and the standard must both be linear but the resistance values of the two need not be the same.

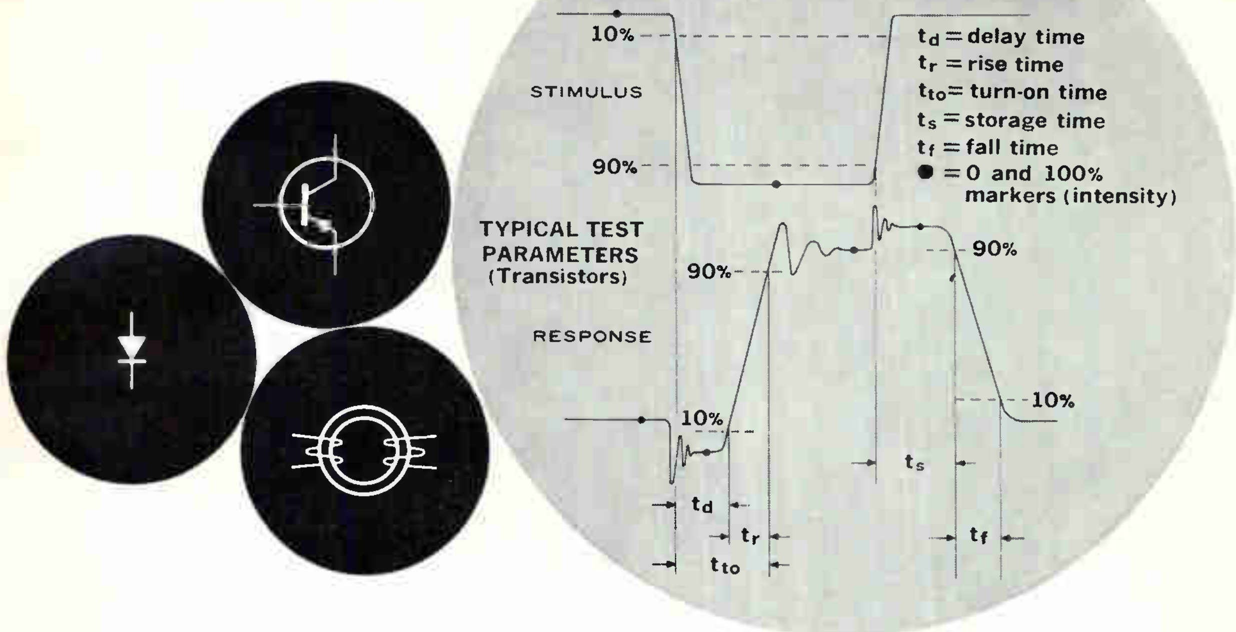
Figure 1A shows the basic circuit for testing linearity by comparison. In this case the potentiometers must have identical resistance. If the two potentiometers are zeroed together the indicator will show zero voltage. If the wipers are then locked together and rotated, the indicator will continue to indicate zero if the potentiometers are identical. If they are different, an error voltage proportional to the difference is developed.

Figure 1B shows calibration curves for a linear test potentiometer and a linear standard potentiometer which have different active lengths. However, the calibration curve for each is a straight line. If the two straight lines can be made to coincide at two points, they should coincide at all points unless there is nonlinearity in one potentiometer. In Fig. 1C the two curves have been made to coincide at the two end turns on the test potentiometer. When the test potentiometer is not perfectly linear, the resulting error voltage is $\pm E_2$, the difference between the curves.

Small-arc potentiometers or small straight potentiometers used in turn-rate gyros, accelerometers, and pressure transmitters can be tested in the circuit shown in Fig. 2A. The standard potentiometer can be a shelf item wirewound potentiometer with one or more turns. The ratio gear train connects the test potentiometer wiper to the standard potentiometer wiper such that when the test wiper moves over the entire active portion of the test potentiometer, the standard potentiometer wiper covers just under 100 percent of the standard potentiometer. To make the calibration curves of the test and standard potentiometers coincide, the test potentiometer wiper is first moved to the end turn at point *C*, and the standard pot wiper is simultaneously driven near *A*; R_1 is then adjusted to give a zero reading on the recorder. Then the test wiper is moved to point *D* (standard pot wiper to near *B*) and R_2 adjusted for zero. If R_1 and R_2 are initially

High-Speed, Automatic Digital Readout

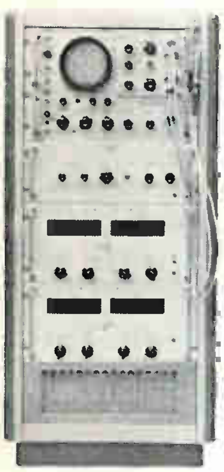
NANOSECOND PULSE MEASUREMENTS



Up to four accurate digital measurements in ¼ second—new automatic convenience for production testing, incoming inspection, quality control of transistors, diodes, magnetic cores, high speed components and circuits!

The Dymec 5844 Automatic Waveform Measuring System provides digital readings of rise, fall, delay and storage time, as well as other dynamic parameters. Go/no-go production testing capability adds further flexibility and efficiency.

With this system you can measure time intervals between any two points chosen from the 0 to 100% level of either stimulus or response pulse. In addition, absolute values can be selected for such applications as measuring diode reverse recovery time. The system also can be used to measure pulse amplitude, pulse area and stored charge. The system is designed for unattended operation with automatic normalizing of 0 and 100% levels on stimulus and response waveforms.



Unique features of the DY-5844

Dual inputs—measure stimulus, response pulses simultaneously, 100 K input impedance for minimum circuit loading.

High accuracy—better than ±3% of full scale, ±0.4 nsec.

Digital readouts—4-digit display for each measurement, plus electrical output for data recording and comparison.

High speed—selected parameters measured in ¼ second. Easily integrated with automatic handling equipment.

Visual monitoring—Oscilloscope display of both pulses simultaneously.

Optional pulser and test fixture—applies stimulus to device under test.

A complete digital pulse measurement system for $8,000 to $12,000, depending on options selected.

For full details contact your Dymec/Hewlett-Packard representative or call direct.

See this system at the Hewlett-Packard booth at Wescon.

DYMEC
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7289

badly out of adjustment it may be necessary to repeat the adjustments. When the wipers are moved so that the test wiper covers the entire test potentiometer, the recorder will record any difference in the calibration in the two potentiometers. A standard potentiometer can easily be obtained that will have an accuracy sufficiently great that all error can be attributed to the test potentiometer. To minimize loading effects, the resistance of R_1 and R_2 should be no greater than one-twentieth of the resistance of the test potentiometer.

The gear train itself must be free of backlash. Precision gears are available as stock items from electromechanical component manufac-

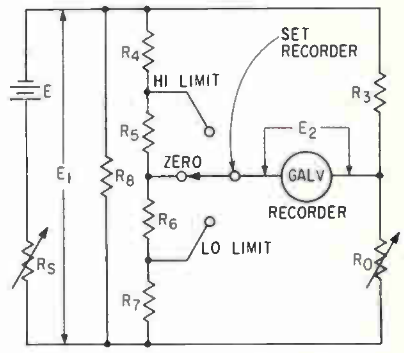


FIG. 3—Recorder calibrating circuit

turers and gear trains can be made even for small arc potentiometers. For a rectilinear potentiometer, the wiper of the test pot can be coupled to a micrometer spindle and the standard pot coupled to the micrometer barrel. As the micrometer barrel is turned, the standard potentiometer wiper and the test wiper move over their respective potentiometers.

A calibrating circuit for the recorder is shown in Fig. 3. In the HI LIMIT or LO LIMIT position of the switch there is a ratio unbalance equal to the linearity tolerance of the potentiometer. Resistor R_8 is adjusted so that the test network loads the battery; R_s is adjusted such that E_1 in Fig. 3 is equal to E_1 in Fig. 2. To calibrate, the recorder is first zeroed by adjusting R_0. Then the switch is turned to the HI LIMIT and LO LIMIT positions respectively, with the recorder chart running, and the maximum and minimum recorder excursions are marked on the recorder chart. In Fig. 4 these calibration marks are shown as tol-

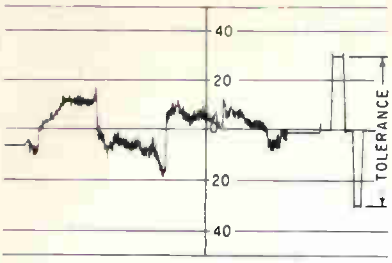


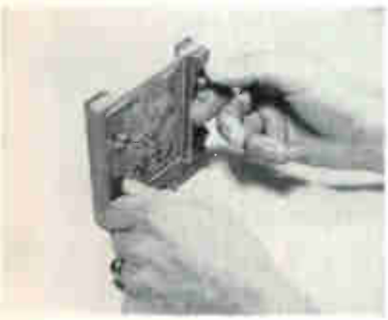
FIG. 4—Calibration record with tolerance marks for a closed loop potentiometer

erance. The spread of the tolerance can be changed by varying R_x. As the wiper moves over the test potentiometer, the error voltage will not exceed the calibration marks if the potentiometer is within tolerance. It can be allowed to exceed one mark if the spread remains less than the calibration spread.

A method of testing round, closed-loop potentiometers of the type used on turnrate gyros is shown in Fig. 2B. The standard is a single turn wirewound potentiometer that is a slight modification of a catalog item. The 1-to-2 gear ratio allows the test wiper to move over one quadrant while the standard covers 180 degrees. Electrically the two are equal.

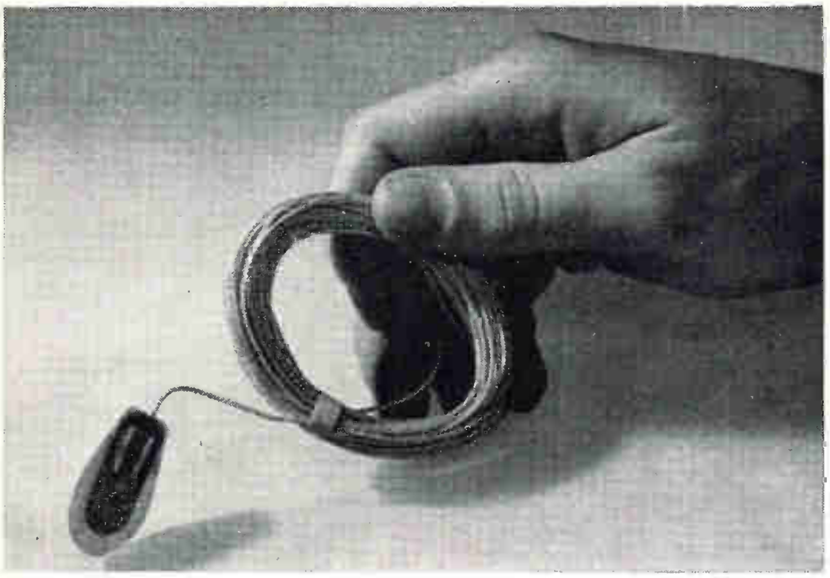
Figure 4 shows a calibration chart for a closed loop potentiometer. The sudden breaks are caused by quadrant taps slightly out of position. The potentiometer is still within tolerance.

Rubber-Lined Clamp for Encapsulation



Rubber-lined clamp fixture enables printed circuit boards to be encapsulated on all surfaces where this treatment is desired. The fixture is used by Kollsman Instrument Corporation, Syosset, New York, when specifications require clean edges or when the boards have printed contact fingers. The company found other means impractical because epoxy would creep, causing extra cleaning as well as damage to delicate sections

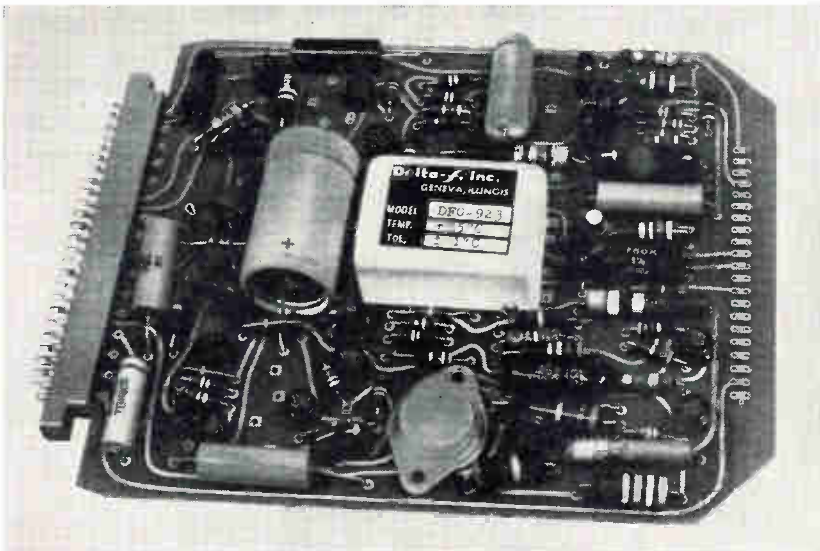
New On The Market



Pressure Transducer
SIDE OR END LEAD CONSTRUCTION

SPITZ LABORATORIES, INC., Yorklyn, Del. Series 210 Filpip pressure transducers are designed for the lower pressure, −10 to 10 psig range. They are linear, have high frequency response, low hysteresis and high sensitivity. Total thickness is 0.035 in.; overall size 1 in. by 1 in. Sensitive area is 1 cm^2. They respond only to normal forces. Because of their low mass/stiffness ratio they may be subjected to high vibration and acceleration with little error. Temperature shifts are small.

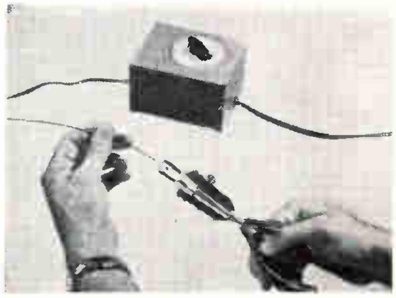
CIRCLE 301 ON READER SERVICE CARD



Crystal Oven
FOR PRINTED CIRCUIT BOARD

DELTA-F, INC., 113 E. State St., Geneva, Ill. Series DFO-923 and 924 crystal ovens will accept one HC/6, HC/13 or HC/18 crystal; temperature stability of ±2 C from −55 C to 5 C below operating temperature, or ±0.5 or better in limited ambient. A warm-up time of less than 15 minutes is required with a current drain of 4 to 15 w depending upon temperature range. Weight is less than 2 oz and the oven may be operated at any voltage from 6 v to 115 v a-c or d-c as specified.

CIRCLE 302 ON READER SERVICE CARD



Wire Stripping Plier
THERMAL TYPE

HUNTER TOOLS, 9851 Alburtus Ave., Santa Fe Springs, Calif., offers a light weight plier like design thermal wire stripper. A compact control box with a rheostat wound 80 plus for any degree of heat at the tips, makes it possible to strip any types of insulation from low-temperature vinyl to Teflon. Dwell time (stripping) as fast as $\frac{1}{2}$ sec on small wire (20 g) to 7 sec on large wire (12 g). Another feature is a formica stripping jaw on the side for removing large diameter insulation or long pulls.

CIRCLE 303 ON READER SERVICE CARD

Digital Indicator
MINIATURIZED

THE PATENT BUTTON CO., Waterbury 20, Conn. Miniature Magneline 12 position indicator meets MIL-E-5272C and MIL-E-5400D Class 2, and is available in one or more digit assemblies. Overall size is $1\frac{1}{8}$ in. high by 2 in. deep. A five-digit assembly is approximately $2\frac{1}{2}$ in. wide. Numeral size is $\frac{13}{64}$ in. high. The indicator is a permanent magnet motor which rotates under control of an externally applied d-c

To Contractors and Subcontractors on U.S. Government Projects

NEW TRANSISTOR 2N1645

■ **HIGH RELIABILITY** ■ **ONE WATT POWER OUTPUT AT 100 MC/S**
■ **EFFICIENCY APPROXIMATELY 50%**

The 2N1645 is a diffused base germanium mesa transistor for UHF power amplifiers, frequency multipliers, and very high speed, high current switching applications. Typical turn-on and turn-off times under constant voltage drive conditions are less than 5 and 15 nanoseconds respectively. Power output of one-half watt as a doubler may be achieved up to 250 megacycles.

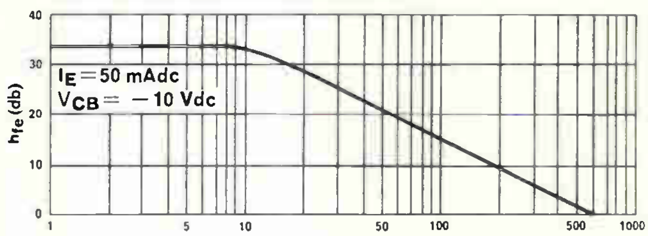
MAXIMUM RATINGS AT 25°C

Collector Current	300 mAdc
Collector Voltage	35 Volts
Emitter Voltage	1 Volt
Junction Temperature	100°C
Power ($T_A = 25°C$)	1 Watt
Power ($T_C = 25°C$)	6 Watts

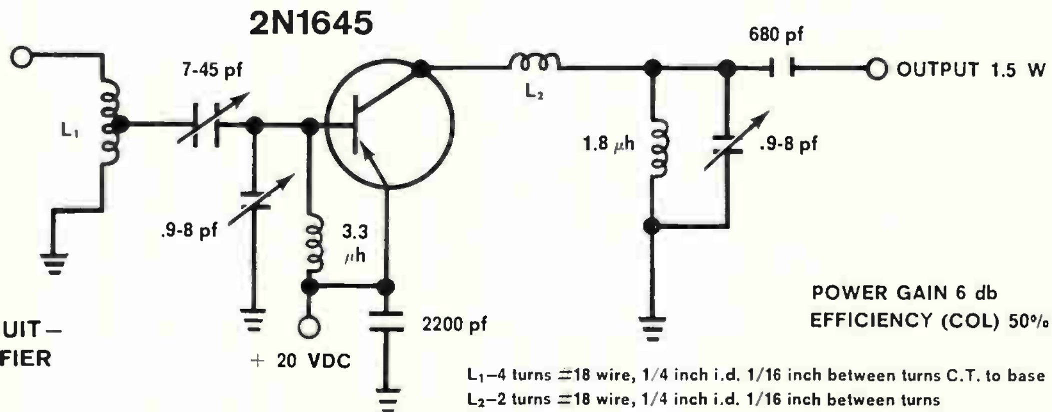
TYPICAL ELECTRICAL CHARACTERISTICS

f_t	600 mc
REh_{ie} (250 mc)	23 ohms
C_{cb} (dir)	10 pf
h_{fe} (1000 cps)	50
h_{FE} ($I_C = 100$ mA)	35

TYPICAL CURRENT GAIN VS FREQUENCY



FREQUENCY IN MEGACYCLES



TYPICAL CIRCUIT—160 MC AMPLIFIER

The 2N1645 transistor may be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to Sales Department, Room 102, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—WAlker 9-9411.

LAURELDALE PLANT

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

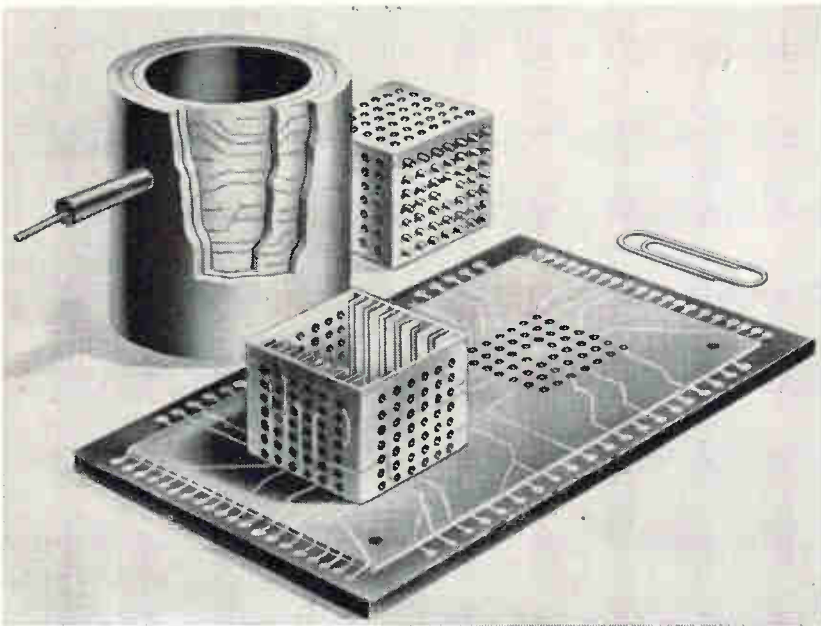
CIRCLE 81 ON READER SERVICE CARD

voltage. The pulsed voltage sets up poles in a permeable core and the permanent magnet aligns itself and brings a specific symbol into position.

CIRCLE 304 ON READER SERVICE CARD

to p-c boards and miniaturized equipment. It measures $\frac{3}{4}$ in. long and $\frac{7}{16}$ in. o-d. Contacts are rated at 2 amp and 1 amp and are of gold flashed special silver alloy. Micro balancing of the armature and rigid assembly of parts permits the relays to conform to severe military and commercial specifications.

CIRCLE 307 ON READER SERVICE CARD



Multilayer Circuit Package
FLEXIBILITY IN MODULE DESIGN

J. FRANK MOTSON CO., Flourtown, Pa. Direct-printed circuit techniques make possible the stacking and interconnections of precision circuits separated by layers as thin as two mils of the Mono-Clad insulation. Circuits can be printed on outside and/or inside (including through hole connections) of geometric shapes such as cubes, spheres, tubes, etc., in copper, silver, nickel, gold and rhodium. Interconnections can be made to any circuit level and printing techniques can carry circuits over edges and around corners.

CIRCLE 305 ON READER SERVICE CARD

Thermostat
FULLY ADJUSTABLE

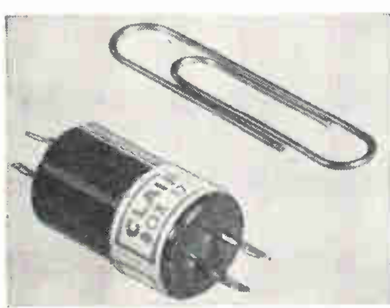
ASTRO CONTROLS, INC., 78 Glenridge Ave., Montclair, N.J. Type TH-500 low price subminiature switch is open construction type and fully adjustable. These units are suitable for the control of both commercial and military type equipment. They are used to directly sense various functions or can be combined with magnetic relays to increase load capacity and contact configurations. General construction is two temperature sensitive members insulated from each other with glass or ceramic spacers.

CIRCLE 308 ON READER SERVICE CARD

Precise Filters
MAGNETOSTRICTION TYPE

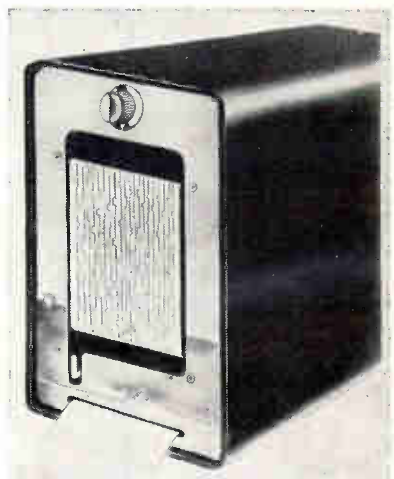
SPECTRAN ELECTRONICS CORP., Maynard, Mass., announces the FS series narrow-band-pass magnetostriction filters. Over the temperature range of −55 to 85 C, temperature coefficient is better than 7 ppm/deg C; for −20 to 50 C it is better than 4 ppm/deg C. Filters have a Q of approximately 6,000, and a range of resonant frequencies from 30 to 300 Kc. Individual filters have the response curve of a series-tuned L-C circuit with a skirt slope of 6 db/band width octave. Units occupy less than 1 cu in.

CIRCLE 306 ON READER SERVICE CARD



Magnetic Relays
SUBMINIATURE

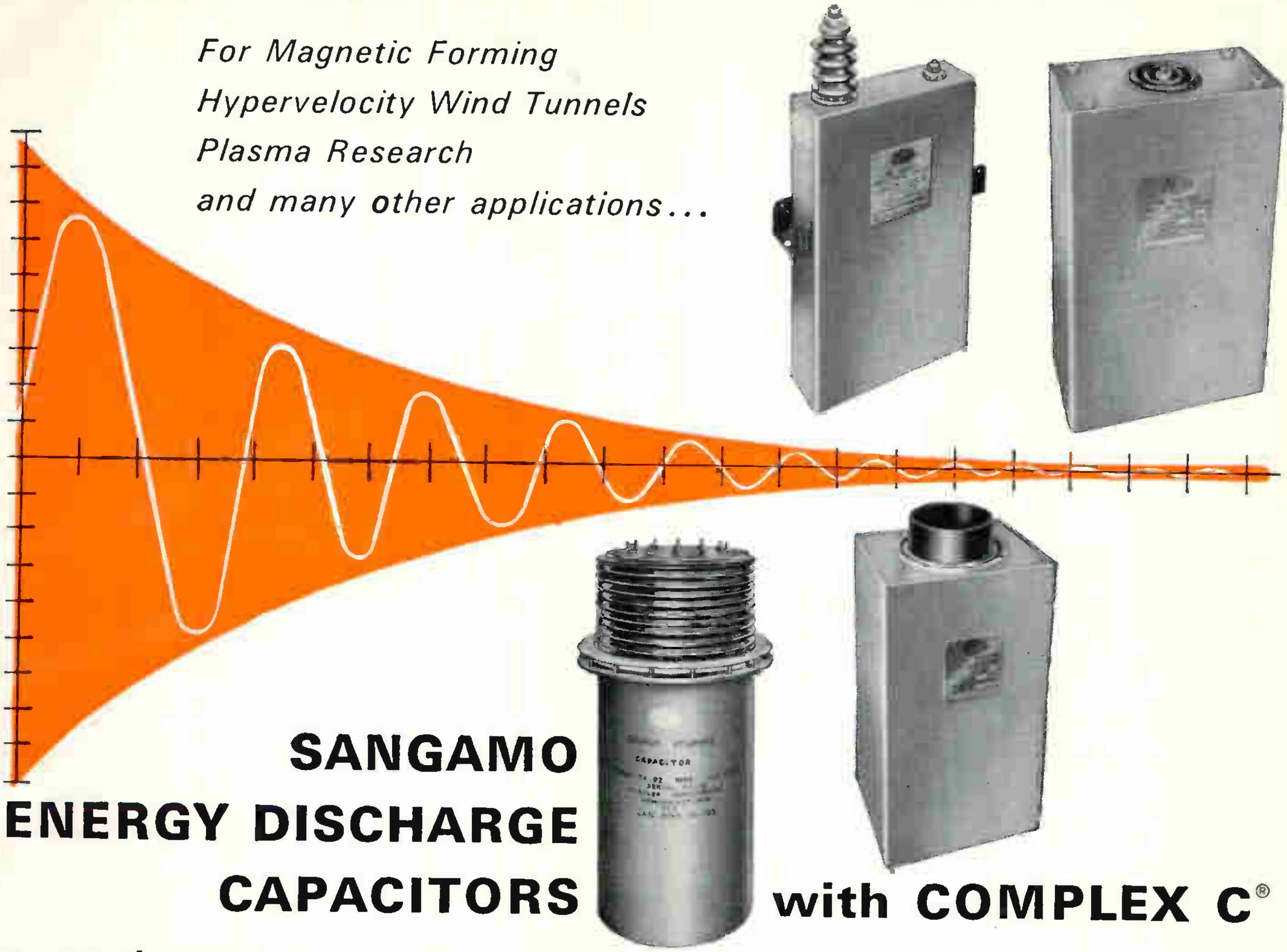
CLAIRTRON MFG. CO., 78 Glen Ridge Ave., Montclair, N. J. The MX-500 series is a versatile relay adaptable



Event Recorder
DEFLECTION TYPE

TECHNI-RITE ELECTRONICS, INC., 45 Centerville Road, Warwick, R. I., announces a 20-channel event recorder for military and precision industrial applications. Model TR-120 monitors up to 20 "on-off" events simultaneously on a single heat sensitive chart roll. Problems of ink control and stylus alignment are eliminated by use of the Miracle Tip stylus, which records against a knife edge for sharper,

For Magnetic Forming
Hypervelocity Wind Tunnels
Plasma Research
and many other applications...



SANGAMO ENERGY DISCHARGE CAPACITORS with COMPLEX C®

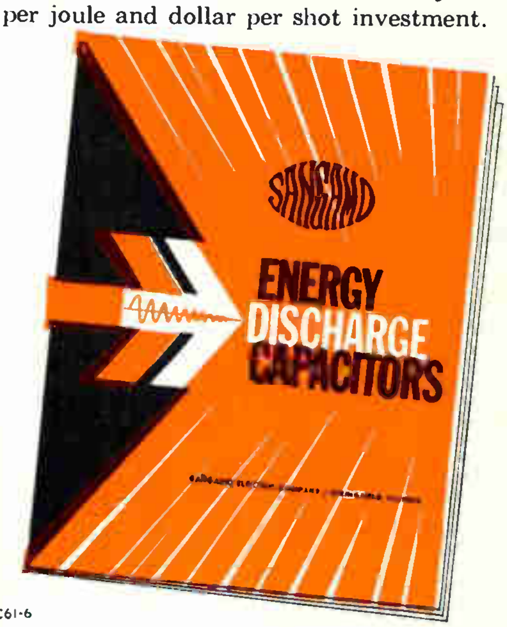
meet the most demanding electrical and mechanical design criteria

Sangamo *knows* energy discharge capacitors and their application—a Sangamo research team has spent years in establishing detailed design criteria to meet the requirements of every conceivable capacitor bank. The energy discharge units developed by Sangamo meet the exact requirements specified, in order to give you the most for your investment in a large energy discharge capacitor bank.

The most significant advance in this field is the development of Complex C (Sangamo's exclusive dielectric impregnant and fill). The use of Complex C, with all other characteristics and circuit conditions being equal, results in a life expectancy 10 to 100 times that previously possible. The exceptional life expectancy of Sangamo Complex C capacitors will give you the most for both your dollar per joule and dollar per shot investment.

SEND FOR SANGAMO'S BULLETIN TSC-208 FOR FULL INFORMATION ON THESE CAPACITORS

The complete story of the design criteria behind Sangamo high voltage, low inductance, energy discharge capacitors is told in detail in this new bulletin. It contains valuable information on possible circuit applications, methods of determining self-inductance of a capacitor, and standard capacitor listings that represent typical values for your energy discharge applications. Your copy will be sent on request. Address:



SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

SANGAMO
ELECTRONIC COMPONENTS

EC61-6

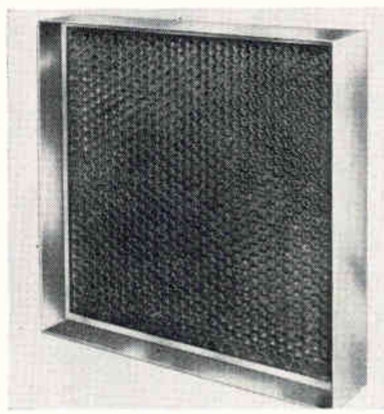
cleaner traces. Also featured is a front-loading "drop-in" chart system, allowing replacement of economical 150 ft chart rolls in 10 sec.

CIRCLE 309 ON READER SERVICE CARD

Transformer

PCA ELECTRONICS, INC., 16799 Schoenborn St., Sepulveda, Calif., offers a 10 Kv pulse transformer designed for application as either a plate coupling or blocking oscillator transformer, in pulse widths up to 1 μsec.

CIRCLE 310 ON READER SERVICE CARD



R-F Radiation Filters
LIGHT-WEIGHT STEEL

FILTRON CO., INC., 131-15 Fowler Ave., Flushing 55, N. Y., announces Attenu-ducts designed to provide maximum cooling and ventilation while also maintaining effective shielding against electromagnetic energy. Series 1200 are r-f radiation filters made of honeycombed, light-weight, completely welded and plated steel. They cover the range from 150 Kc to over 3,000 Mc and provide attenuation in increments of 27 db over this spectrum. Maximum static pressure equals 0.1 in. of water at 1,200 fpm air velocity.

CIRCLE 311 ON READER SERVICE CARD

Low-Level VCO

TELE-DYNAMICS DIV., American Bosch Arma Corp., 5000 Parkside Ave., Philadelphia 31, Pa. Subcarrier oscillator, designed to operate at unlimited altitudes, as actuated by ±5 mv level differential signal for full IRIG deviation output.

CIRCLE 312 ON READER SERVICE CARD

INTEGRATOR an analog accumulator. Elcor, Inc., 1225 W. Broad St., Falls Church, Va. **(313)**

D-C/D-C VOLTAGE REGULATOR solid state circuits. Moore Associates, Inc., 893 American St., San Carlos, Calif. **(314)**

BU/ORD SYNCHROS operate from −55 to +85 C. Kearfott Division, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J. **(315)**

RECEIVER-TRANSMITTER for COM/NAV system. Aircraft Radio Corp., Boonton, N. J. **(316)**

PROXIMITY COUNTER mounts on production line. Five Mile Electronics Corp., Allegany, N.Y. **(317)**

NYLON ZIPPER high dielectric strength. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y. **(318)**

MULTIPLIER PHOTOTUBE for scintillation counters. Radio Corp. of America, Harrison, N.J. **(319)**

PRIMARY RATIO REFERENCE 1 part in 10 million accuracy. Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N.Y. **(320)**

A-C VOLTAGE STANDARD solid state, low cost. Delta-f, Inc., 113 E. State St., Geneva, Ill. **(321)**

TRANSISTORIZED INVERTERS general-purpose. Dynamic Instrument Corp., Syosset, N.Y. **(322)**

DIGITIZER for microscope readings. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. **(323)**

TRANSFER FUNCTION ANALYZER direct reading. Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N.J. **(324)**

NOISE SOURCE POWER SUPPLY 2,000 v starting pulse. Trak Electronics Co., Inc., Wilton, Conn. **(325)**

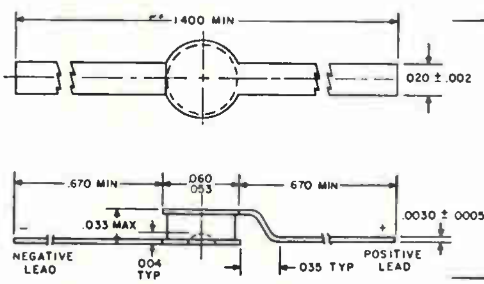
CROSSBAR SCANNER reliable, flexible. James Cunningham, Son & Co., Inc., 33 Litchfield St., Rochester, N.Y. **(326)**

ACOUSTIC SERIAL MEMORY stores 1,600 bits at 16 Mc. Computer Control Co., Inc., 983 Concord St., Framingham, Mass. **(327)**

semiconductor products news

Good Things Come in Small Packages

. . . is an old saying often used by mothers and fathers who don't want to give the kids too much candy. Big things are nice in their place too, of course, like say a Rolls Royce, or a Chris Craft. But when you're designing very high speed computer circuits, you've got to agree with Mom and Dad. Small packages *are* important. And the new G-E MSD-150 microminiature silicon switching diode is a perfect case in point. *Planar Epitaxial Passivated* construction makes possible a diode having high conductance, fast recovery time, low leakage and low capacitance combined with improved uniformity and reliability. Minimum conductance is 50 ma at one volt; recovery time is less than 2 nanoseconds. And just try this outline drawing on for size:



The standard subminiature SD-150 PEP diode is available in matched pairs and matched quads for highest performance and reliability in discriminators, gates, choppers, ring modulators and bridge modulators. Just ask for complete information on G-E *PEP* diodes when you write to Section 16K112.

QUESTION: *Where can I get a Planar Epitaxial Passivated silicon transistor with the lowest V_{CE} (sat.) which will replace standard units without changing circuits?*

ANSWER: *At G-E, of course. Ask about the new 2N2193-2195 PEP transistors, with "A" versions.*

The Power-Size Ratio

There wouldn't be much sense in putting a 350 hp motor in a Volkswagen, matching a tall lightweight with a short heavyweight, sending a boy to do a man's job, or arguing with the swift, sure logic of a woman. What would it get you? But putting *15 watts power dissipation at 25°C case temperature* into a compact, rugged and reliable silicon power transistor gets you a power-size ratio that means important benefits in aircraft servo and industrial power supply applications. The new G-E 2N2201-2204, 2N2196-2197 series and other types offer you 16 different devices in your choice of 4 different packages to satisfy your particular circuit requirements. Applications include:

- servos
- power supplies
- dc to dc converters
- dc to ac inverters
- static switching

We also have an interesting hi-fi circuit developed using the 2N2196. We'll part with it for free. Just write to us at Section 16K112.

Now hear this: a germanium epitaxial mesa transistor with typical 45 nanosecond switching speed in conservative circuitry and Beta of 60, in a TO-18 package . . . and available now! Ask your District Sales Manager about the new G-E 2N994. You'll be glad you did.

PUT PEP IN YOUR DESIGNS

Need specs? Have questions? Write Semiconductor Products Department, Section 16K112, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 East 42nd St., New York 17, N.Y.

GENERAL ELECTRIC

CIRCLE 87 ON READER SERVICE CARD

Literature of the Week

CERAMIC SEALS Litton Engineering Laboratories, P.O. Box 949, Grass Valley, Calif., has available a catalog of ceramic seals and components—enclosures and lead-in terminals. (328)

INSTRUMENT CHOPPERS James Electronics, Inc., 4050 No. Rockwell St., Chicago 18, Ill. A 12-page catalog gives complete data on the company's military and industrial choppers. (329)

PAPER-TAPE REELER Omnitronics, Inc., 511 N. Broad St., Philadelphia 23, Pa. Bulletin RS-300, revised, brings up to date the information on model RS-300 bidirectional paper-tape reeler. (330)

T-W AMPLIFIER Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. Technical bulletin describes the WJ-226 ultra low-noise traveling-wave amplifier. (331)

EPOXY SEALANT Isochem Resins Co., 221 Oak St., Providence 9, R. I. Bulletin announces the Isochemseal 822 line of epoxy sealant that comes in three viscosities plus a variety of hardeners. (332)

ULTRASENSITIVE TRANSDUCER Sensonics, Inc., 952 Shoreham Building, Washington 5, D. C., has available a specification sheet and price list for a variable piezoelectric transducer. (333)

GERMANIUM AND SILICON DIODES American Elite, Inc., 48-50 34th St., Long Island City 1, N.Y. Technical data manual describes by specification and curve sheets a complete line of Telefunken germanium and silicon diodes. (334)

MICROWAVE SYSTEMS Lenkurt Electric Co., Inc., San Carlos, Calif. Volume 10 No. 9 of the *Demodulator* contains Part 1 of two articles on the design of a new, high-capacity transistorized microwave system. (335)

R-F CONNECTORS The Deutsch Co., Municipal Airport, Banning, Calif., announces a 10-page catalog on a line of subminiature coaxial connectors. (336)

DATA ACQUISITION SYSTEM Genisco, Inc., 2233 Federal Ave., Los

Angeles 64, Calif. Folder describes a 10-channel analog-to-pulse duration system. (337)

T-W TUBES Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif., announces an 8-page illustrated and diagrammed twt catalog. (338)

PRECISE POSITION REPEATER Theta Instrument Corp., 520 Victor St., Saddle Brook, N.J. Preliminary specifications for a precise position repeater are given in a 2-page bulletin. (339)

MICROWAVE WAVEGUIDE Andrew Corp., P.O. Box 807, Chicago 42, Ill., has published a waveguide supplement to its microwave antenna catalog. (340)

TRANSISTOR BASES Electrical Industries, Murray Hill, N.J. A single-sheet bulletin deals with a line of hermetically sealed transistor bases. (341)

RESOLVER Vernitron Corp., 602 Old Country Road, Garden City, N.Y. Bulletin describes sweep size 23 resolver for 1,000 cycle operation. (342)

EPOXY RESINS Mitchell-Rand Mfg. Corp., 51 Murray St., New York 7, N.Y. A four-page folder compares 17 Randac epoxy resins in an easy-to-read chart form. (343)

PRESSURE TRANSDUCER Taber Instrument Corp., 107 Goundry St., North Tonawanda, N.Y. Bulletin P-61185 introduces a miniature airborne pressure transducer. (344)

MILITARY SPECIFICATIONS The Macallen Co. Inc., Newmarket, N.H. Four-page bulletin No. 13 incorporates military specifications for insulations. (345)

TRANSMISSION LINE TESTING Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. Transmission line testing using the sampling oscilloscope is discussed in *Application Note* 53. (346)

PRESSURE INDICATORS Pall Corp., 30 Sea Cliff Ave., Glen Cove, N.Y. Bulletin E5 and six data sheets cover Deltadyne pressure and differential pressure indicators. (347)

TUBE CATALOG Eitel-McCullough, Inc., San Carlos, Calif. Accurate selection of all standard Eimac tube types is possible with a 48-page quick-reference catalog. (348)

New Plant Marks Decade of Growth

COMPLETION of a quarter-million dollar plant last month, and two recently acquired major military contracts mark the latest milestones in a program of planned development and growth for Republic Electronics of Huntington, N. Y.

It all started in a downtown Manhattan loft office in 1951 when a 27-year old engineer, Tom Lo Giudice, now the company's president and chief executive officer, and a young assistant, Ed Kovacs, started out as TLG Electronics. The Korean conflict provided the initial contracts, mainly for electronic test and ground support equipment.

Soon Lo Giudice was convinced that the young company's future lay exclusively in defense electronics and this became its operating principle. Some 120 defense contracts have been filled.

Early this year, the company's performance record paid off with award of two Air Force contracts totaling more than $2 million. One is for development and production of more than 400 MG-3 radiation monitoring devices; the other, for development and production of 45 ssb communications systems.

Company sales for the first quarter this year were a record $515,470, almost equal to total sales for the previous fiscal year. First quarter earnings of $41,588 almost matched earnings for the entire 1960 fiscal year and were nearly five times 1959.

Lo Giudice maintains that although diversification into non-government business is possible, it will not be pursued aggressively until yearly sales reach $5 million. He predicts this level should be reached in two years. In anticipation, the new building has been designed to permit expansion to 40,000 square feet, double present capacity.

This is the company's third expansion since 1957. In 1959 it went from Manhattan to a 6,000-square-foot building in Farmingdale, L.I. By the end of that year it became necessary to increase space to 12,000 sq ft by taking an adjoining building.

The decision for a new building was made in early 1961 and the company began moving in after Labor Day.

The new facility provides 20,000 square feet and houses the present staff of 75 which is expected to double, to 150, within the next 90 days. The building features a spacious, well-lighted production area, and air-conditioned sales, purchasing and engineering offices in colorful, modern decor.

Hane Joins Ortronix As Project Engineer

WALTER E. HANE has joined Ortronix, Inc., Orlando, Fla., as project engineer in charge of the telemetry group.

Hane was formerly a group engineer with Martin-Orlando. Here he had the responsibility for the development and application of the Pershing missile airborne telemetry and signal conditioning equipment. He was also instrumental in developing a new airborne system for transmitting missile inverter frequency data to ground stations with ultraprecise accuracy.

Vitro Electronics Names Stephens

ROBERT R. STEPHENS has been appointed chief electronics engineer for Vitro Electronics, Silver Spring, Md., a division of Vitro Corp. of America. He had been chief engineer for General Electronics Laboratory.

Vitro Electronics supplies electronic equipment, primarily telemetry receivers, to all military services under the Nems-Clarke brand.

Polarad Electronics Appoints Schwalbe

POLARAD ELECTRONICS CORP., Long Island City, N.Y., announces the appointment of Stanley Schwalbe to manager of engineering planning. Schwalbe joined the company in 1959 as staff assistant to the vice

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Pulse and Digital Circuits by J. Millman and H. Taub. Explains circuits for effective electronics systems design.

Publisher's Price, $13.50
Club Price, $11.50

Magnetic Amplifier Engineering by G. M. Attura. Gives principles and applications of magnetic amplifiers.

Publisher's Price, $7.50
Club Price, $6.40

Handbook of Semiconductor Electronics by L. Hunter. Covers principles of operation, manufacturing, applications.

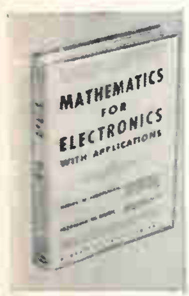
Publisher's Price, $14.00
Club Price, $11.90

Transistor Circuits and Applications edited by J. M. Carroll. Hundreds of transistor circuits for scores of applications.

Publisher's Price, $10.00
Club Price, $8.50

Electronic Measurements by F. Terman and J. Petit. 2nd Ed. Covers measurement fundamentals in radio, TV, radar and other pulsed systems.

Publisher's Price, $12.50
Club Price, $10.65

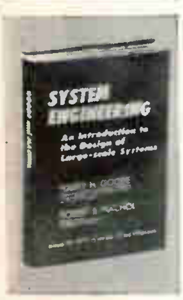


Mathematics for Electronics with Applications by H. M. Nodelman and F. W. Smith, Jr. Mathematical methods for solving over 300 typical electronics problems.

Publisher's Price, $7.00
Club Price, $5.95

Electronic Designers' Handbook by R. Landee, D. Davis, and A. Albrecht. Detailed, practical design data on electronics circuits for all types of equipment.

Publisher's Price, $16.50
Club Price, $14.05



System Engineering — An Introduction to the Design of Large-scale Systems by H. H. Goode and R. E. Machol. Modern methods for solving problems of large-scale systems.

Publisher's Price, $11.50
Club Price, $9.80

Electronic Digital Computers by C. Smith Explains principles and operations of arithmetic, circuits, and components in modern digital computers.

Publisher's Price, $12.00
Club Price, $10.25

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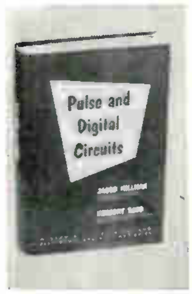

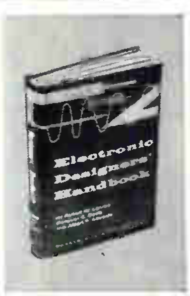

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L-11-24

president of the Defense Products division.

Polarad designs and manufactures microwave test equipment and electronic instrumentation.

General Mills Hires Stone

RICHARD L. STONE has joined General Mills, Inc., Minneapolis, Minn., as instrument and control systems product manager in the electronic and mechanical defense products department.

Prior to his association with General Mills, Stone was with the General Electric Co. for more than four years.

Micro-Power Appoints Rosenfeld President

AARON ROSENFELD has been appointed president of Micro-Power, Inc., Long Island City, N.Y., manufacturer of power supplies for microwave tubes. He was formerly chief engineer for Kepco, Inc.

Form New Corporation To Engage in Telemetry

DATA-TRONIX CORP., was recently formed in Norristown, Pa., to engage in research, development and production of advanced telemetry components and systems.

Terence R. Gregory, formerly

vice president of Sonex, Inc., is president; David N. Dry, formerly chief engineer of Sonex, Inc., is vice president; and Carl S. Waynebern, president of Serendipity Service, is secretary-treasurer.

Company has established its plant in Norristown, with a mailing address of P.O. Box 37, King of Prussia, Pa.

Motorola Division Names Knowles

C. HARRY KNOWLES has been named assistant general manager for research and advanced development for Motorola's Semiconductor Products Division, Phoenix, Ariz.

Before joining Motorola in 1958, Knowles was a member of the technical staff of Bell Telephone Laboratories, Murray Hill, N.J., where he was responsible for the development of h-f germanium transistors, power transistors, and switching diodes.

General Microwave Appoints Sweet

GENERAL MICROWAVE CORP., Farmingdale, N.Y., has oppointed Leonard O. Sweet to the post of chief microwave engineer. In this capacity he is directly responsible for all aspects of microwave engineering effort, encompassing both external and company-sponsored programs.

Sweet was formerly head of the

CIRCLE 93 ON READER SERVICE CARD

microwave section at PRD Electronics, Inc.

Associated Press Promotes Kimbell

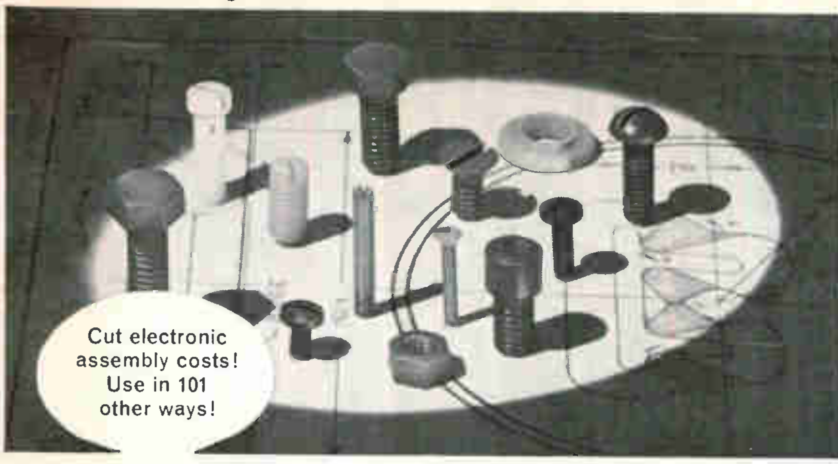
E. BLANTON KIMBELL, a veteran of 28 years with the Associated Press, has been named to the new position of manager of research and development. He will coordinate and supervise all AP activities in the technological field.

Kimbell will be assisted by C. H. McDonald as chief of maintenance and by C. W. Hubley as chief electronics engineer and head of the 30-year-old AP electronics laboratory.

PEOPLE IN BRIEF

The Plessey Co. Ltd. promotes **R. L. Higgin** to general manager, components group. **Albert E. Beckers**, formerly with Allen B. DuMont Laboratories, joins Hughes Aircraft's Vacuum Tube Products div. **R. D. Rhodes** leaves Fairchild Stratos Corp. to become director of industrial engineering for Kollsman Instrument Corp. **William B. Turner** from Lionel Electronic Laboratories to manager of the research dept. of the Capehart Corp. **John H. Sokol**, ex-International Silver Co., named production supervisor at Vitramon, Inc. **Richard L. Snyder**, previously with Philco Corp. and ITT, now industrial engineer at Uniform Tubes, Inc. **Bernard J. Weiss** advances at Raytheon to engineering mgr. of the microwave and production equipment dept. **Louis P. McNeill**, ex-RCA, appointed quality control manager at Communication Measurements Laboratory, Inc. **Harry E. Weaver** and **James T. Arnold** move up at Varian Associates' Instrument div. to mgr. of optical pumping and cryogenics research, and mgr. of research in geophysics and space physics, respectively. **Howard E. Harry**, formerly with General Dynamics, appointed engineering mgr. for the electronics div. of The Ralph M. Parsons Co. **Joseph M. Welty**, ex-Raytheon Semiconductor, joins Shockley Transistor as chief engineer.

Before you order... check NYLO-FAST® FASTENERS!



Have you investigated what NYLO-FAST® Fasteners can do for you? They're colorful, strong—yet 1/6 the weight, chemical resistant, heat resistant, elastic, resilient, and non-conducting! You'll be surprised to discover how many ways NYLO-FAST® Fasteners can serve you—BETTER! Write for complete information.

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METAL PRODUCTS COMPANY, Inc.
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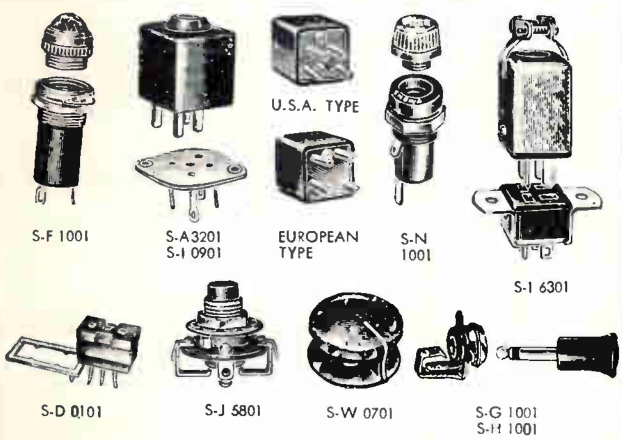
SMK RADIO, TV PARTS AND OTHER ELECTRONIC COMPONENTS



The SMK components are exported in large quantities to foreign markets at the lowest possible prices with the highest quality available.
We are always making strenuous efforts to make a new design and improve every product in quality.
We are proud of our production capacity which is claimed to be the largest in the Orient. Catalogue available on request.

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CIRCLE 204 ON READER SERVICE CARD

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.

ELECTRODYNAMIC INSTRUMENT CORPORATION
Subsidiary of Reed Roller Bit Company
JA 6-3761 • 1841 Old Spanish Trail • Houston 25, Texas

CIRCLE 95 ON READER SERVICE CARD

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

STRICTLY CONFIDENTIAL

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

WHAT TO DO

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

COMPANY	SEE PAGE	KEY #
A C SPARK PLUG Electronics Div. of General Motors Corp. Milwaukee, Wisconsin	211*	1
AMERICAN MACHINE & FOUNDRY COMPANY Stamford, Connecticut	97	2
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pennsylvania	97	3
ESQUIRE PERSONNEL Chicago, Illinois	97	4
GENERAL ELECTRIC COMPANY Electronics Park Syracuse, New York	97	5
I B M CORP. New York, New York	217*	6
JET PROPULSION LABORATORY Pasadena, California	216*	7
JOHNSON CONTROLS Milwaukee, Wisconsin	221*	8
LAWRENCE RADIATION LABORATORY Livermore, California	221*	9
MOTOROLA, INC. Military Electronics Div. Western Center Scottsdale, Arizona	220*	10
NATIONAL SCIENTIFIC LABORATORY INC. Washington, D. C.	97	11

CONTINUED ON OPPOSITE PAGE

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS..

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

HOME TELEPHONE..

Education

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

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 11241

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from opposite page)

COMPANY	SEE PAGE	KEY #
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick AFB, Florida	67*	12
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	219*	13
REPUBLIC AVIATION CORP. Farmingdale, L.I., New York	218*	14
TEXAS INSTRUMENTS INCORPORATED Apparatus Div. Dallas, Texas	221*	15

*These advertisements appeared in the 11/17/61 issue.

MANUFACTURERS' REPRESENTATIVES
IN THE ELECTRONIC INDUSTRY

SAMUEL K. MACDONALD, INC.
manufacturers representatives over 25 years
1531 SPRUCE STREET, PHILA. 2, PA.

Territory:
Pennsylvania • New Jersey
Delaware • Maryland
Virginia • West Virginia
District of Columbia

Other Offices:
Pittsburgh
Baltimore
Washington, D.C.

SEARCHLIGHT SECTION
(Classified Advertising)
BUSINESS OPPORTUNITIES
EQUIPMENT — USED or RESALE

●

DISPLAYED RATE

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

UNDISPLAYED RATE

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

PROPOSALS, 2.40 a line an insertion. BOX NUMBERS count as one line additional in undisplayed ads.

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

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

RADAR SYSTEMS & COMPONENTS / IMMEDIATE DELIVERY

CIRCLE 460 ON READER SERVICE CARD

BUILDING FOR SALE

Cape Canaveral Area—Modern comb. ofc. & whse. bldg. Panelled ofcs., conference rm. & genrl. ofc. area, approx. 2750 sq. ft., all air conditioned. Whse. area approx. 5250 sq. ft. Some furn., fixtures & ofc. equip. available. Ideal for small electronics co.

Call REYNOLDS: PArkway 3-5851.
or write: P. O. Box 1596, Melbourne, Florida

CIRCLE 461 ON READER SERVICE CARD

SEARCHLIGHT Equipment Locating Service
No Charge or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used Electronic equipment not *currently* advertised. (This service is for USER-BUYERS only.)

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in his section. You will receive replies directly from hem.

Searchlight Equipment Locating Service
c/o ELECTRONICS, P.O. Box 12, N.Y. 36, N.Y.
Please help us locate the following equipment components.

. . . .

NAME . . . .
TITLE . . . .
COMPANY . . . .
STREET . . . .
CITY 11/24/6

first choice of all 4

research

design

production

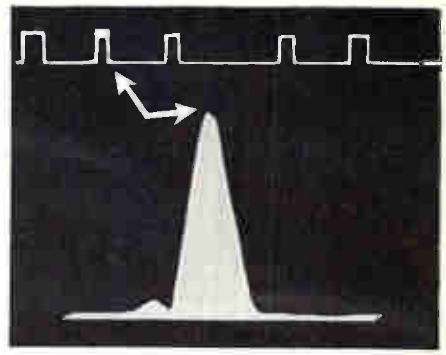
management

Because the BUYERS' GUIDE satisfies the buying and specifying needs of all four segments of the industry! Gives more information in less space. Easier to use. Only the BUYERS' GUIDE has been *screened for usefulness* over a 20 year period . . . comes to you compact, complete and accurate.

gives more to all 4!

electronics BUYERS' GUIDE and REFERENCE ISSUE

Pick any pulse for spectrum analysis



Spectrum Analyzer Display, showing 2nd pulse in a train of 5, isolated by Spectrum Selector SD-1.

Polarad's Multipulse Spectrum Selector, Model SD-1, is the *only* instrument that permits a spectrum-analyzer examination of any individual pulse within a multipulse train.

The spectrum selector automatically gates a spectrum analyzer during the interval of pulse analysis and can be used with any analyzer with an IF of 160 mc (140 mc available on special order).

Pulse selection and gating are visual. The entire pulse group is displayed on the instrument's CRT, and any one pulse in the group is brightened to indicate its selection for analysis. A group of pulses up to 180 microseconds (350 microseconds on special order) in length can be accommodated. Sweep expansion permits detailed examination of closely spaced pulse groups.

For complete specifications, write Polarad or call your local Polarad Representative (he's listed in the Yellow Pages).

Multipulse Spectrum Selector Model SD-1

POLARAD
ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N.Y.

CIRCLE 208 ON READER SERVICE CARD

INDEX TO ADVERTISERS

Audited Paid Circulation

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

■

INDEX TO CLASSIFIED ADVERTISERS

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

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

electronics

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Audited Paid Circulation

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ADVERTISING REPRESENTATIVES

NEW YORK (36):
Donald H. Miller, Henry M. Shaw, George F. Werner, Robert M. Denmead
500 Fifth Avenue, OXford 5-5959
BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copley Square, Congress 2-1160
PITTSBURGH (22):
David M. Watson
Four Gateway Center, Express 1-1314
PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOcust 8-4330
CHICAGO (11):
Harvey W. Wernecke, Martin J. Gallay
645 North Michigan Avenue, Mohawk 4-5800
CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000
SAN FRANCISCO (11):
T. H. Carmody, R. C. Alcorn
255 California Street, Douglas 2-4600
LOS ANGELES (17):
Marshall Freeman, Peter S. Carberry
1125 W. 6th St., Huntley 2-5450

DENVER (2):
J. W. Patten
Tower Bldg., 1700 Broadway, Alpine 5-2981
ATLANTA (9):
Michael H. Miller
1375 Peachtree St. N.E., Trinity 5-0523
HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Holcomb Blvd., Jackson 6-1281
DALLAS (1):
Frank Le Beau
The Vaughn Bldg., 1712 Commerce St.
Riverside 7-9721
LONDON W1:
Dennis McDonald
34 Dover St.
FRANKFURT/Main:
Stanley R. Kimes
85 Westendstrasse
GENEVA:
Michael R. Zeynel
2 Place du Port

From
BOMAC

An Industry First

4.3 MM BALANCED DUPLEXERS
68.75 - 70.75 kMc

Bomac Laboratories presents a 4.3 Millimeter Balanced Gas Switching Duplexer . . . an industry first from Bomac's advanced development in radar and microwave components.

The BLP-017D duplexer is the first ever designed for 4.3 mm operation. This rugged short-slot hybrid duplexer assures reliable service under severe environmental conditions. Operable in excess of 500 hours, at temperatures from −40° to +85° C. It's lightweight — weighs less than 4 oz. And it's small: volume, only 1.4 cubic inches.

Switches 15 kW peak power at 0.0006 duty cycle. Available in many configurations to meet customer requirements.
Applicable to high definition radar systems.

BLP-017D Duplexer
(shown half-again actual size)

Electrical Characteristics:

- 68.75-70.75 kMc ■ 2.0 μs Recovery Time
- 0.005 erg Spike Leakage ■ 5.0 mw Flat Leakage
- 0.9 db Duplexer Loss ■ 1.3 VSWR

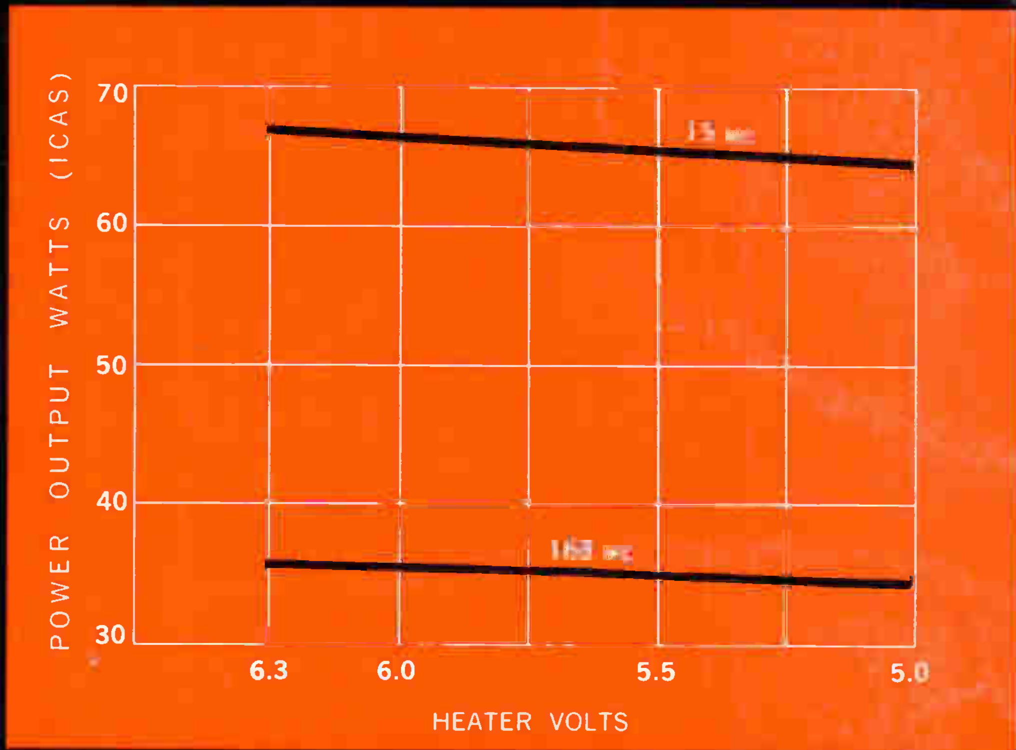
You'll want to know more about the BLP-017D Duplexer, and other quality Bomac microwave tubes and components. Write for technical literature.

BOMAC laboratories, inc.

BEVERLY 1, MASSACHUSETTS
A Varian Subsidiary

VARIAN ASSOCIATES, INC.
S-F-D LABORATORIES, INC.
VARIAN ASSOCIATES OF CANADA, LTD.
SEMICON ASSOCIATES, INC.
SEMICON OF CALIFORNIA, INC.
VARIAN A.G. (SWITZERLAND)

RCA-6146 — OUTSTANDING FOR MOBILE OPERATION   MEETS THE SAME PERFORMANCE REQUIREMENTS AS THE 6146A



Performance of typical RCA 6146 at 15 Mc and 168 Mc as heater voltage drops

RCA 6146—90 watts CW input up to 60 Mc; 67.5 on phone

The RCA-6146 Closely Maintains Power Output–When Heater Voltage Drops

The original RCA-6146 design stands out. Here's a beam power tube that closely maintains power output even at maximum capability—when heater voltage drops. At 5 volts, the drop-off is about 1 watt! The RCA-6146 does this easily—and in the normal mobile frequency range.

Here are some of the reasons that make the RCA-6146 world famous: A grid-cooling collar provides improved grid dissipation, and minimizes grid emission for long life; a threefold heater gives uniform cathode heating—reduces cathode hot spots; a new integral cathode tab eliminates weak weld structure in the cathode area—assures cathode continuity; a new getter is control-flashed in non-critical areas of the tube to minimize rf losses.

So for your OEM design, specify RCA-6146 with confidence. It meets Military Specification MIL-E-1/380C. Companion types available include the 12.6-volt heater version (RCA-6883) and the 26.5-volt heater version (RCA-6159). Just call your RCA Representative, or order directly from your RCA Industrial Tube Distributor.

RCA ELECTRON TUBE DIVISION

RCA® The Most Trusted Name in Electronics

RCA ELECTRON TUBE DIVISION FIELD OFFICES

INDUSTRIAL PRODUCT SALES . . . NEWARK 2, N. J., 744 Broad St., HU 5-3900 • CHICAGO 54, ILLINOIS, Suite 1154, Merchandise Mart Plaza, WH 4-2900 • LOS ANGELES 22, CALIF., 6801 E. Washington Blvd., RA 3-8361 • BURLINGAME, CALIF., 1838 El Camino Real, OX 7-1620. GOVERNMENT SALES . . . HARRISON, N. J., 415 So. Fifth St., HU 5-3900 • DAYTON 2, OHIO, 224 N. Wilkinson St., BA 6-2366 • WASHINGTON 7, D.C., 1725 "K" St., N.W., FE 7-8500