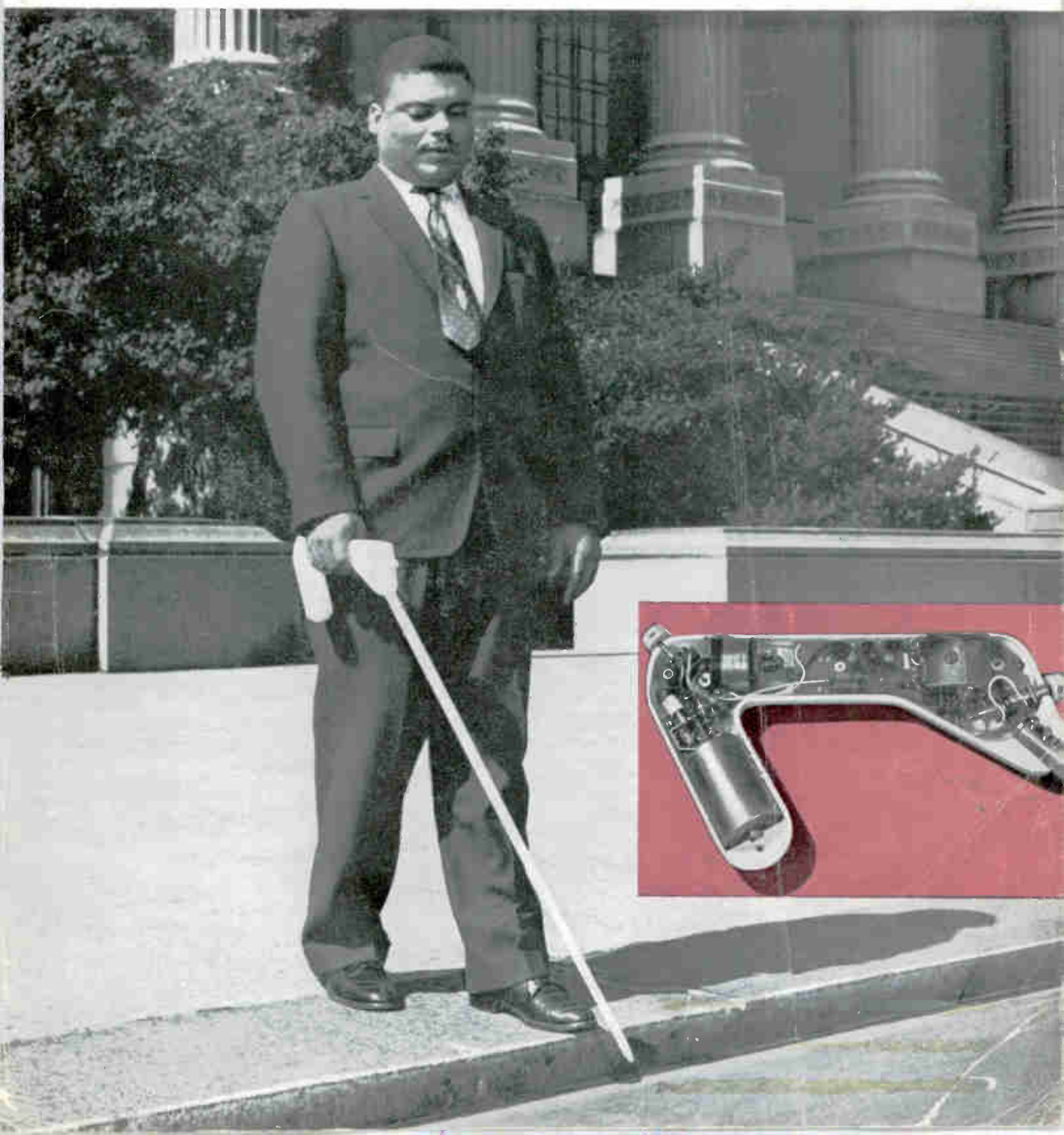
June 23, 1961

electronics

Radio-frequency guidance device in head of cane (inset) helps blind man detect obstacles and pitfalls. *See p 43*

Controlled rectifier produces quarter-megawatt pulse power, *p 54*

A McGraw-Hill Publication 75 Cents



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The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS
All types for frequencies from .1 cycle to 400 MC.


400 ~ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ~, ⅝ x 1¼ x 2"


15 ~ BP filter, 20 db at 30 ~, 45 db at 100 ~, phase angle at CF less than 3° from −40 to +100°C.


LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85°C., 45 db at 55 KC.


LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

PULSE TRANSFORMERS
From miniature blocking oscillator to 10 megawatt.


Wound core unit .01 micro-second rise time.


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Pulse output to magnatron, bifilar filament


Precise wave shape pulse output, 2500 V. 3 Amps.

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Tuned DO-T servo amplifier transformer, 400 ~ .5% distortion.


Toroid for printed circuit, Q of 90 at 15 KC.


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Saturable reactors, reference transformers, magnetic amplifiers, combined unit.


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200° C. power transformer, 400 ~, 150 VA.


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June 23, 1961

electronics

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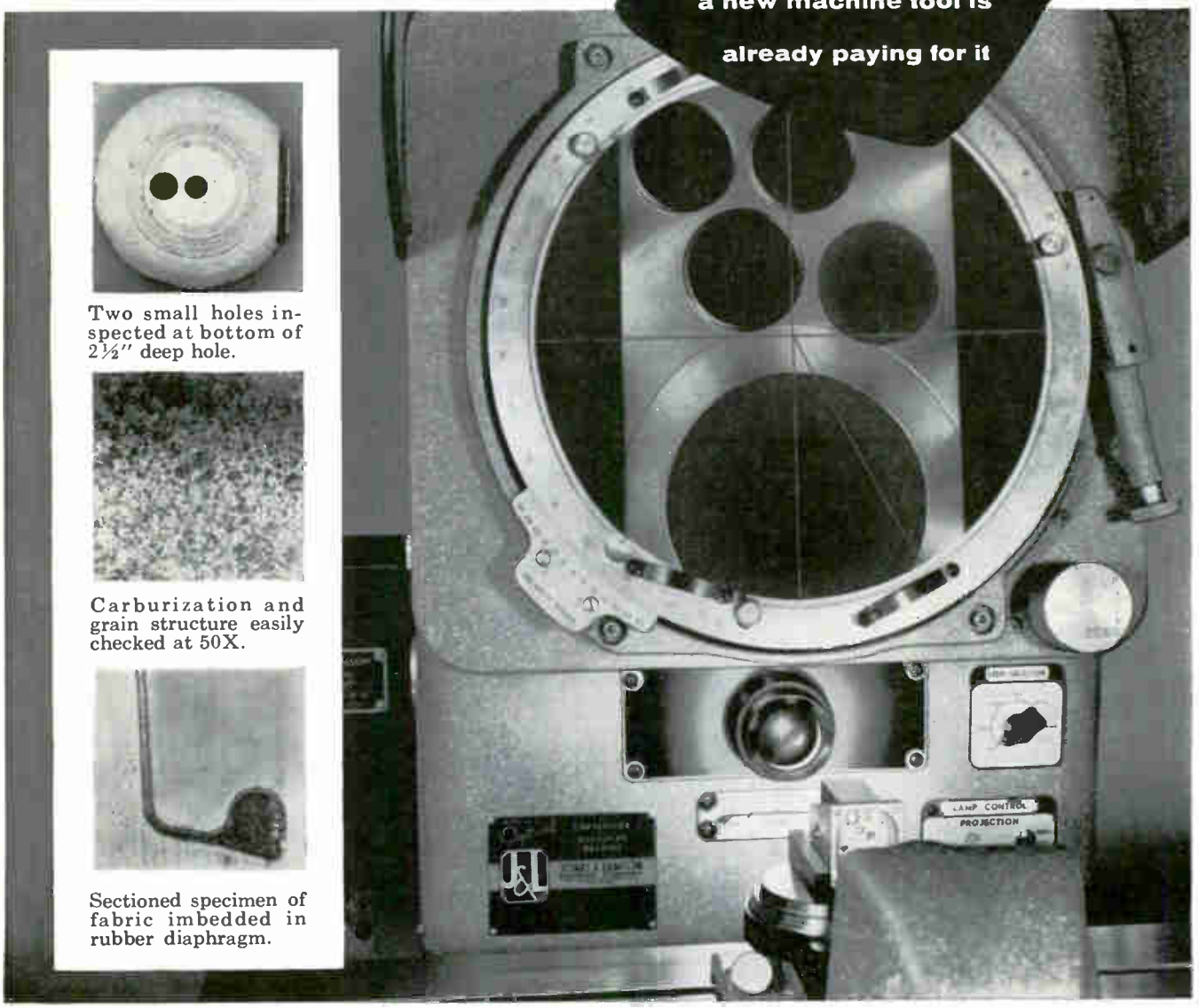
JONES & LAMSON OPTICAL COMPARATORS

the man who needs a new machine tool is already paying for it



Two small holes inspected at bottom of 2½" deep hole.

Carburization and grain structure easily checked at 50X.

Sectioned specimen of fabric imbedded in rubber diaphragm.

New reflection unit makes "tough" inspections easy

Now, users of J & L FC-14 and TC-14 Optical Comparators can easily and accurately inspect cast materials, deep holes, and penetration of heat treat, and can make their over-all inspection operations more efficient than ever before.

J & L's new Normal Reflection Unit, shown here, is designed to produce the maximum amount of reflectivity, *regardless of the surface finish of the part being inspected.* This new unit gives brighter-than-lifelike images, with clean, razor-sharp definitions, without heat and without distortion.

This revolutionary development makes it possible to inspect by reflection and by projection simultaneously. Reflection can be directed from above, below, or either side. Effective light is increased at least 55% by means of a spherical reflector, which concentrates and redirects light into the optical system.

With J & L's True Telecentric Lens System, depth of focus of up to .100" can be obtained. And the image does *not* change size during focusing! The entire unit, is externally mounted to isolate convected heat from the optical system.

Write for free, illustrated folder LO-5918. Jones & Lamson Machine Company, 539 Clinton Street, Springfield, Vermont.

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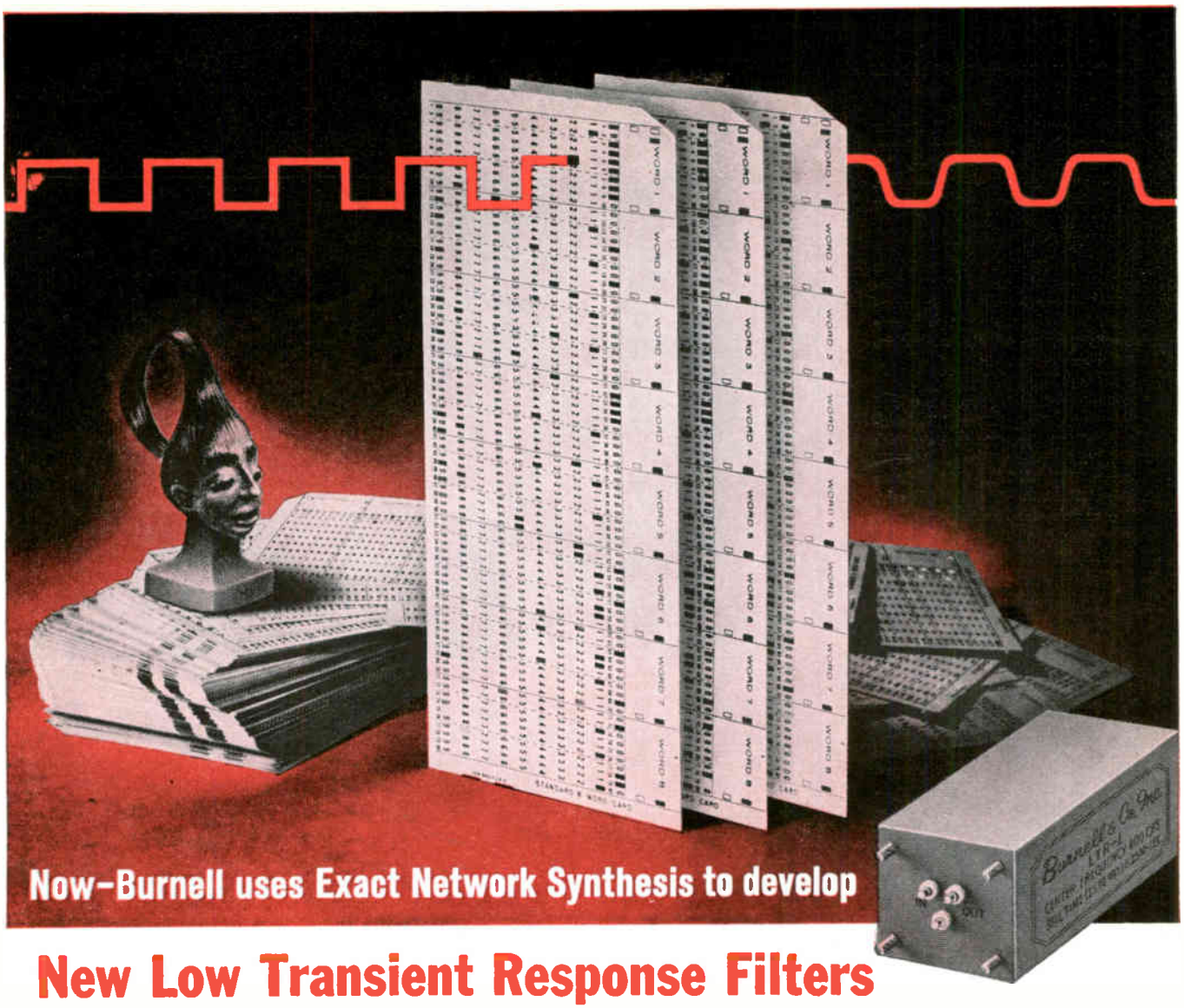


New Low Transient Response Filters

New digital computer techniques for network synthesis have enabled Burnell & Co. to produce filters possessing the special time and steady state properties so essential to today's high precision, communication, data and guidance systems. An example of this achievement is the Burnell Type LTR-1 which overcomes problems formerly insoluble through the use of standard design procedure.

More than a linear phase band pass achievement, this new Burnell "low ringing" filter combines the center frequency, band width, rise time and attenuation characteristics that insure minimum phase distortion and low transient response. Hermetically secure, the LTR-1 easily shrugs off shock, vibration, acceleration and other hazards encountered in extreme environments.

TECHNICAL DATA

Center frequency: 400 cps

Pass band width: (3db) down +20% —16.5% of center frequency

Attenuation: 30 db at one-half and twice center frequency

Overshoot: ("low ringing") 1%

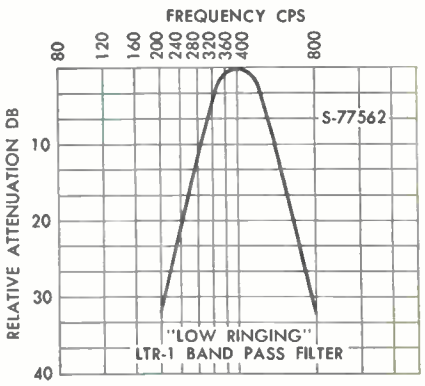
Rise time: (1% to 99%) 6.25 ms.

Meets MIL-F 18327A specifications.

If your circuit needs can not be met by the LTR class of filters or our stock of more than 15,000 specialized filter designs, Burnell engineers will, of course, manufacture to your specifications.

Write for Filter Bulletin.

With the aid of our new Guillemin Research Laboratory, we are now able to solve your network problems in an even wider range than ever before.



Write for your membership card in the Space Shrinkers Club.

Burnell & Co., Inc.

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electronics
June 23, 1961 Volume 34 Number 25

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CROSSTALK

MEDICAL ELECTRONICS.—The coronation of England's Edward VII on August 9, 1902 marked the end of the Victorian era, and the beginning of the hearing aid business. During the ceremonies, Queen Alexandra used a hearing aid invented just that year by Miller Reese Hutchinson. Amplification was provided by a carbon microphone that drove an electromagnetic earphone. This development was made possible by the invention of the telephone in 1867 which, strangely enough, came out of Alexander Graham Bell's attempt to develop hearing aids for children.

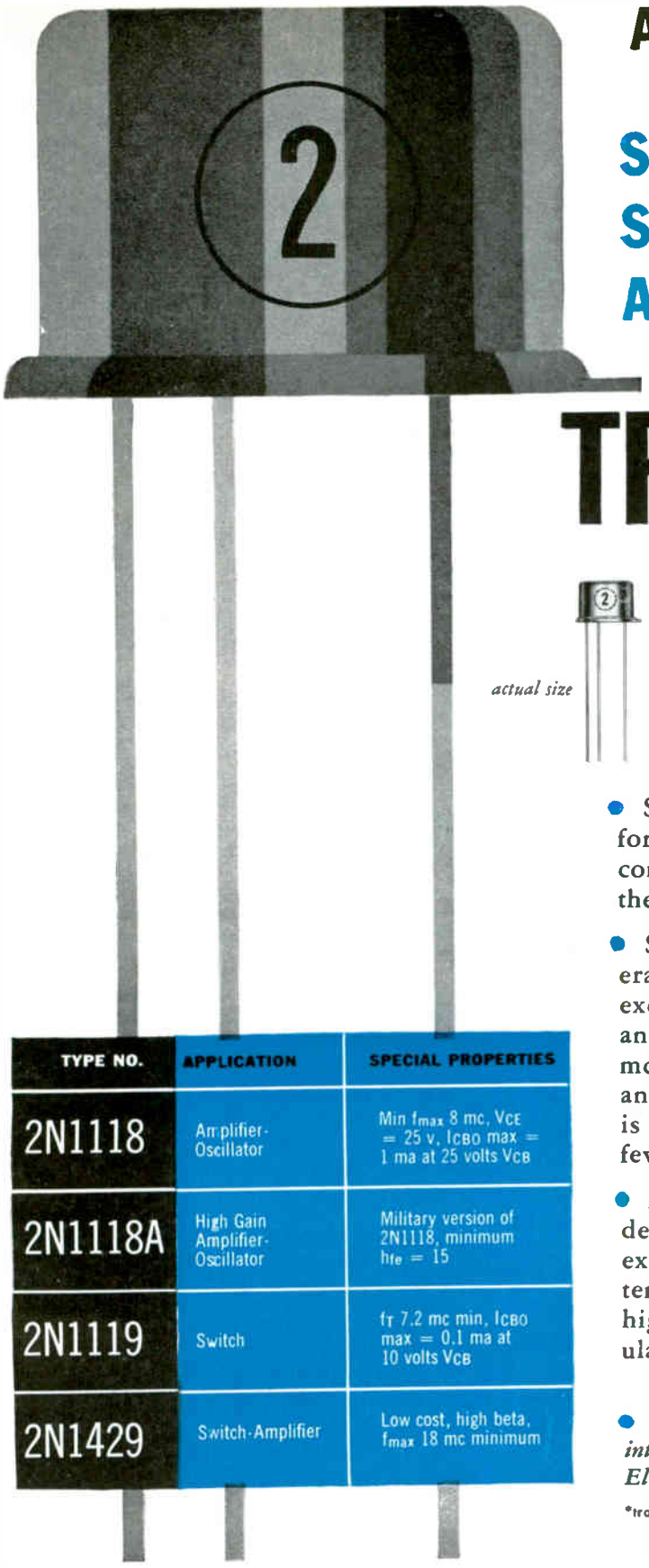
Reduction in size and increase in effectivenesses of hearing aids since 1902, particularly after the innovation of vacuum tubes in the 30's and transistors in the 50's, has been phenomenal. Complete aids adequate for many hearing deficiencies can now be worn completely in the ear.

The more critical, if less widespread, affliction of blindness has not yet been significantly alleviated through electronics although researchers insist practical devices could be developed given enough money and psychologically-oriented electronics engineers. Except for the Talking Book (magnetic or disk recordings of a person reading a book) there are no electronic guidance or reading aids for the blind in widespread use today.

Although the VA and others vitally interested have spent much money trying to find a technological solution, the basic problem appears to go deeper. The difficulty is lack of understanding of the quite subjective nature of the ultimate user. As seen in Associate Editor Bushor's article in this issue (p 43), numerous ideas and equipments have been produced, but most fail because the interpretation of whistles, tones, beeps and the like are left to the users who have varied comprehensive abilities, just as you or I. The information gap between the user, the device and the environment must be bridged. And this will take a better marriage between the electronics and the life sciences.

Coming In Our June 30 Issue

FEATURE MATERIAL to appear next week includes: a radar computer output display that traces alphanumeric characters by K. E. Perry and E. J. Aho of MIT Lincoln Lab; testing microwave transmission lines with sampling oscilloscopes by H. Halverson of Hewlett-Packard; and a graphical design procedure for maximally flat microwave filters by M. Chomet of Airborne Instruments Lab.



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COMMENT

Electronics in Europe

Just a note to let you know that I think your "Electronics in Europe" article in the June 9th issue is tremendous. I enjoyed your thorough presentation of the European picture and also your purely personal column very much.

It is such presentations as yours which make ELECTRONICS the outstanding magazine in the industry.

TINY YEWELL
YEWELL ASSOCIATES, INC.
BURLINGTON, MASS.

Cheers and hearty Hear! Hears! on your fine "Electronics in Europe" report.

Indeed, your report was much more than capable, comprehensive coverage of The Continent's electronics industry . . . In my opinion, your "Purely Personal" remarks added a lively new (and needed) dimension to trade reportorial techniques.

I'm looking ahead to more of your peak to pique personal observations along with your cogent industry coverage.

RICHARD ENGNATH
RICHARD ARMS ADVERTISING, LTD.
NEW YORK 21, N. Y.

Your report on Electronics in Europe impressed me very much.

It is unquestionably the best presentation I have seen, my congratulations.

ERIC LIDOW
INTERNATIONAL RECTIFIER CORP.
EL SEGUNDO, CALIF.

Your . . . "Electronics in Europe", dated June 9, 1961, has been brought to my attention, and I find it most interesting and informative.

I should very much like to have a copy of this issue, and would appreciate your sending me a reprint at the above address. Many thanks.

STEPHEN S. BARONE
RADIO CORPORATION OF AMERICA
NEW YORK 20, N. Y.

Thank you for . . . the copy of "Electronics in Europe". It is an interesting presentation of an industry which is becoming increasingly important the world over.

GUNNAR JARRING
ROYAL SWEDISH EMBASSY
WASHINGTON 8, D. C.

. . . The increased importance of the European market makes information such as this particularly useful at this time.

WALTER W. HELLER
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON, D. C.

Thermoelectricity

We recently received a letter from a friend of ours at the Washington, D. C. headquarters of the European Atomic Energy Community. He relayed the following query:

I would like to illustrate the significance of the story entitled "Report Breakthrough in Thermoelectricity," which appeared in ELECTRONICS, p 49, Nov. 11 '60. The quoted figure of merit of 45×10^{-3} means a maximum thermoelectric energy converter efficiency of 35 percent is possible when hot junction of converter is at 327 C and cold junction at 27 C. Efficiency would be as high as 51 percent if the hot junction could be operated at 627 C. I would like to know the temperatures at which the new converter can be operated and the power densities obtainable. Other pertinent information on the device would be of interest.

DR. C. BUSSE
COMMUNAUTE EUROPEENE DE L'ENERQIE ATOMIQUE
BRUSSELS, BELGIUM

We contacted the Naval Research Laboratories. The following reply was sent by Paul H. Egli:

The particular specimens on which these measurements were made have unfortunately been destroyed in efforts to confirm measurements made by another laboratory. The high figure of merit originally announced has not been achieved on subsequent specimens. Checks made on the original measurements indicate that they were in error. More recent samples of gadolinium selenide have had figures of merit close to 1×10^{-3}.

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All TSI instruments are fully transistorized. They are, therefore, remarkably compact. They run cool. They are completely reliable.

The extensive use of NOR-logic in TSI counter/timers markedly reduces their semiconductor count, simplifying circuitry, increasing operating margins, lowering cost.

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The stability of this instrument is exceptional — 5 parts in 10^8 per week — and entirely consistent with its accuracy: ±1 count ±crystal stability . . . absolute.

The Model 365-R 10MC Counter/Timer/Frequency Meter illustrated is one of 17 modern, dependable digital instruments by TSI. The Model 420 Frequency Extender shown to the right extends the range of the 365-R to 220MC . . . solid state, naturally.

It will pay you to consult TSI when you need digital instrumentation in the real-time domain.

10MC Counter/Timer/Frequency Meter Model 365-R 5¼" panel height. 7-Nixie in-line readout. Functions: Freq. A (0.1 cps — 10MC) Freq. Ratio A/B; Period A to B; Period A (0.1 μsec. to 100 sec.); Period AX10; Self-Test; Freq. Std. (10MC to 0.1 cps.)

220MC Frequency Extender Model 420. Sensitivity, 2MV; Input Frequency Range, 10 to 220MC.

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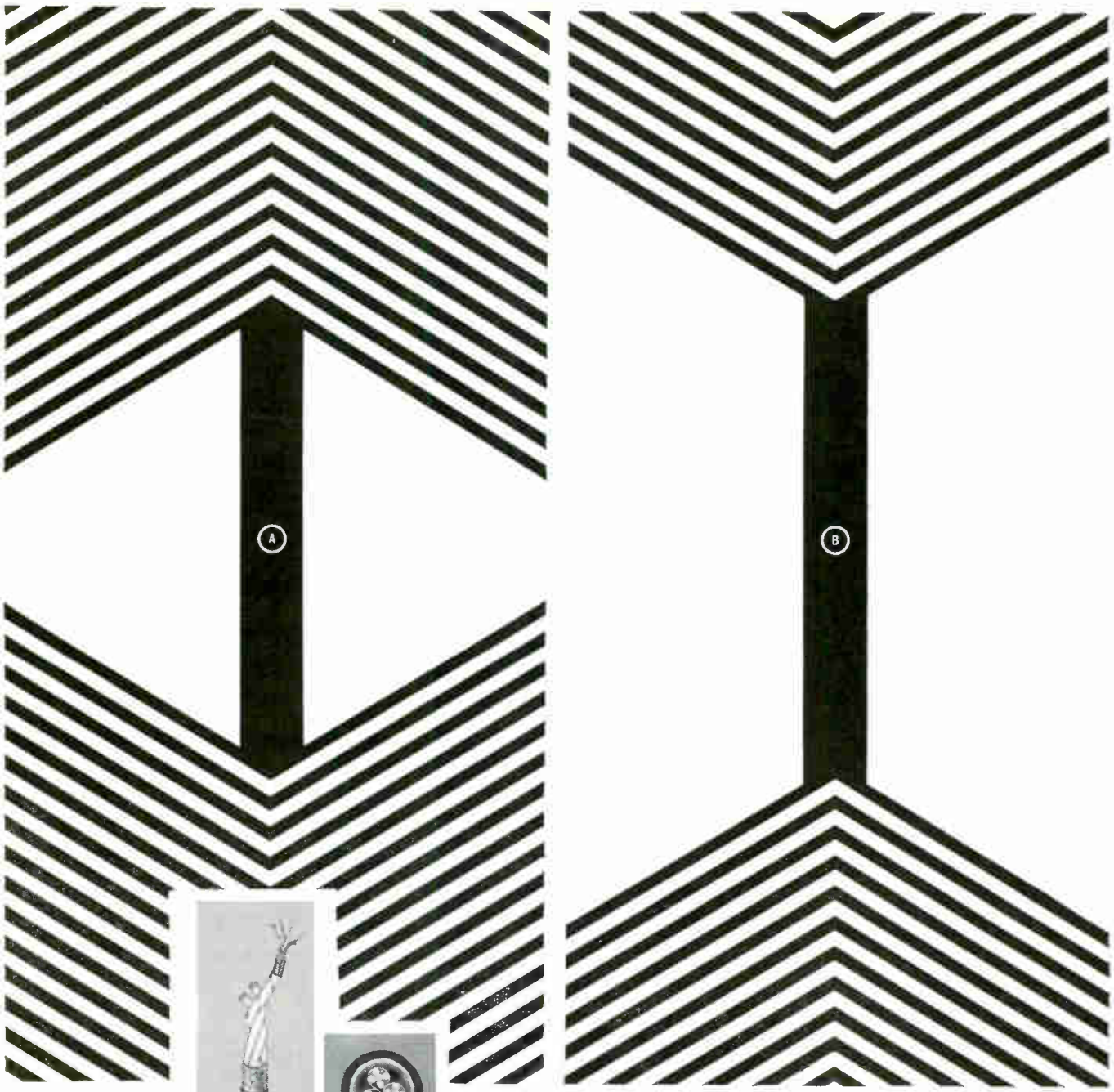
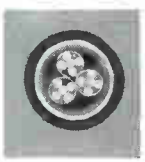
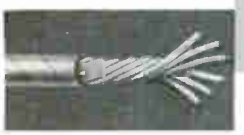


Are A and B the same size?





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We think you'll agree that the art form above gives a deceptive illusion. Wire and cable, too, can create an illusion in that several different brands can look and feel identical—can seem to have comparable quality.

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ELECTRONICS NEWSLETTER

Microcircuit Air-Core Inductors Developed

MICROCIRCUIT air-core inductors, already being used with thin-film capacitors to form bandpass filters in the 10, 20 and 30-Mc range, have been developed by the Solid State section of Motorola Military Electronics division, Phoenix. Other applications are now under consideration, firm says.

Each inductor consists of a 20-turn spiral of 0.001-inch thick copper laid on a substrate. Width of the conductor in one configuration is 0.003 inch and the distance between turns is 0.001 inch. Outer diameter of spiral is 0.270 inch. Inner core has a span of 0.110 inch and contains a land for connecting lead. To date, units have been fabricated having inductance values up to five microhenries and a Q approaching 100 at one Mc.

Motorola points out that one of the major problems in microcircuitry until now has been the storage of magnetic energy in a small volume, and states that these low-value, high-frequency inductors partially answer the question of what to do about inductors.

Computer-Speed Fax Sends 50 Times Faster

COMPUTER-SPEED FACSIMILE—boosting document transmission rates 30 to 50 times—began simulation trials this week over microwave net of seven Videograph transmitter-receiver stations covering 800 miles of Denver and Rio Grande Western Railroad. Full-scale operation of Denver-based system is scheduled to start July 1.

First communications application of A. B. Dick-developed Videograph can transmit 10 waybills—or 15 linear ft of continuous information—a minute, compared to earlier fax system limits of a third of a page a minute, reports Allan Roshkind, vice president, research and engineering.

Automatic-gain-control circuit uses large diameter beam to sense variations in contrast between copy and paper, then automatically adjusts level to accommodate differences in background color values, for small 400-scan-a-second flying-spot scanner. Translated into video pulses for microwave transmission, copy is reconstituted at receiver for printout by crt within five seconds. Sylvania tube brings 0.001-in. stainless cathode-ray steel wires, packed 62,500 per sq in. through face-plate matrix 8½ in. wide to deliver beam's charge variations to surface of coated paper. Dusting of powder adheres according to charge on surface, is fused to spell out message for delivery as hard copy.

Space Communications Issue Causes Split

A SHARP SPLIT has developed within the Administration over industrial ownership of a space communications system. The Federal Communications Commission favors limiting joint ownership of such a system to international communication companies such as AT&T, ITT, etc.

The Department of Justice, however, told Congress recently that ownership should also include electronic equipment makers and domestic communication companies. Undue concentration of the communications industry to only a few companies was cited as a possible reason for limited progress in the field. Lee Loevinger, head of the Justice Department's Antitrust division, told Congress.

The Justice Department's position on ownership of a satellite communication system supports companies such as General Electric that have been protesting the FCC stand. A final decision on the issue is expected to come within the next month or so.

Report Advances In Superconductivity

BASIC THEORY on superconductivity has now advanced to the point where virtually all observed superconductive phenomena can be accounted for and predicted on the basis of the Bardeen-Cooper-Schrieffer theory with recent additions and modifications, Paul Marcus of IBM told ELECTRONICS last Friday.

He said this at the company's Thomas Watson Research Center, where 250 scientists met for a symposium on fundamental research into superconductivity.

Among the practical developments reported were new achievements in cryogenically generated magnetic fields. At Atomics International, fields of 30 kilogauss have been produced with current densi-

Fissionable Material for Diode Emitter?

NOVEL APPROACH under consideration to lick space charge limitation in thermionic diodes involves use of fissionable material for emitter.

Proposed use of fissionable material would provide both source of heat for emitter and a source of radiation which would produce positive ions to negate the space charge. The higher the temperature in a thermionic diode, the greater the flow of electrons and, assuming the space charge problem can be overcome, the higher the efficiency.

More conventional approaches to space-charge limitation are closing gap between emitter and collector to less than 0.001 inch, a technique which introduces tough manufacturing difficulties, and using cesium vapor to inject cloud of positively charged ions to neutralize space charge.

Researchers say use of fissionable material probably is applicable principally to space vehicle and other noncommercial systems.

ties as low as 30 amperes per square centimeter using titanium-molybdenum wire.

True Hermetic Seal Ends Interim Packaging?

DEVELOPMENT work on a true hermetic seal to replace the interim packaging technique used on Westinghouse's functional blocks was announced last week.

Details were given at the Fifth Annual Product Engineering and Production conference, attended by over 500 engineers in Philadelphia. A major portion of the program dealt with problems encountered in translating microminiature approaches from laboratory models to production prototypes.

RCA engineers described how they are overcoming heat transfer, interconnection and module size problems in micromodule gear.

The honeycomb structure employed in Sperry's high density packaging scheme permits replacement of components and simplifies assembly, it was reported. This welded 3-D approach uses predrilled or precast molds of metal or plastic into which parts are positioned.

Litton claims its multilayer plated laminates offer maximum utilization of p-c boards by allowing higher connection density.

Thimble-Size Telemetry Tattles on Wildlife

THIMBLE-SIZE transmitter monitoring ground-bound animals within half a mile can track airborne ducks for 60 miles, William Cochran, electronics engineer and Rex Lord, natural history research associate, told American Society of Mammologists meeting at University of Illinois last week.

Demonstration showed one-ounce transmitter—including four-month battery power source—attached to plastic harness encasing flexible antenna encircling body of a rabbit. Advanced models may replace steady tone with intermittent beep which can telemeter heart or respiration rates of animals under study.

Five-pound, 100-channel receiver packaged in shoebox-size case topped by two-foot directional loop is being rebuilt to permit quick resetting to any of 40 channels identified with certain birds, animals.

Present application—monitoring day and night movements and feeding habits of birds and small animals—barely touches potential of device, according to developers. One observer half-seriously suggested units could have unlimited possibilities in keeping track of youngsters at picnics.

New Contracts Coming For Electronic Buoys

TWO HUGE electronically instrumented ocean buoys will be built for Navy-sponsored acoustic research this year. Purpose is to perform research aimed at improving submarine detection and underwater ordnance technology. Most of the electronic contracts have yet to be awarded.

One buoy, dubbed FLIP (Floating Instrument Platform), will be 355 ft long with a 20-ft base diameter for use in the Pacific. Towed into position, the facility will be flooded so it floats upright with only 50 ft exposed above the surface. Four Scripps Institution of Oceanography scientists will man the buoy for up to two-week periods as it floats freely in the ocean.

Naval Ordnance Laboratory is building a similar but shorter buoy dubbed SPAR (Seagoing Platform for Acoustic Research) for use in the Atlantic Ocean. Unmanned, SPAR will be serviced by two accompanying vessels.

Raytheon Opens Plant in Maine

RAYTHEON has just opened a new semiconductor plant in Lewiston, Me. It starts with 900 employes producing germanium transistors and diodes. A mesa transistor line will move in next year.

Speaking at the dedication Sunday, James E. Girdwood, publisher of ELECTRONICS, said a regional center of advanced scientific research is a vital ingredient for area growth in electronics. Maine Congressman Staley Tupper reiterated the theme and urged state officials and colleges to cooperate in furthering development of advanced scientific electronics research. Raytheon President Richard E. Krafve said at least 50 percent of his firm's research is now in solid state.

Just In . . .

SYLVANIA'S Applied Research Laboratory, under $45,000 Air Force contract, is conducting research into fluctuation of the earth's magnetic field. Effects of sun spots and solar flares also are being studied.

SPARTON ELECTRONICS gets a $1.2-million prime military contract for production engineering and manufacturing of a new Sonobuoy, air-dropped device used in underwater detection of subs.

HALLICRAFTERS CO., Chicago, receives a $33.3-million Air Force contract for radio transmitters.

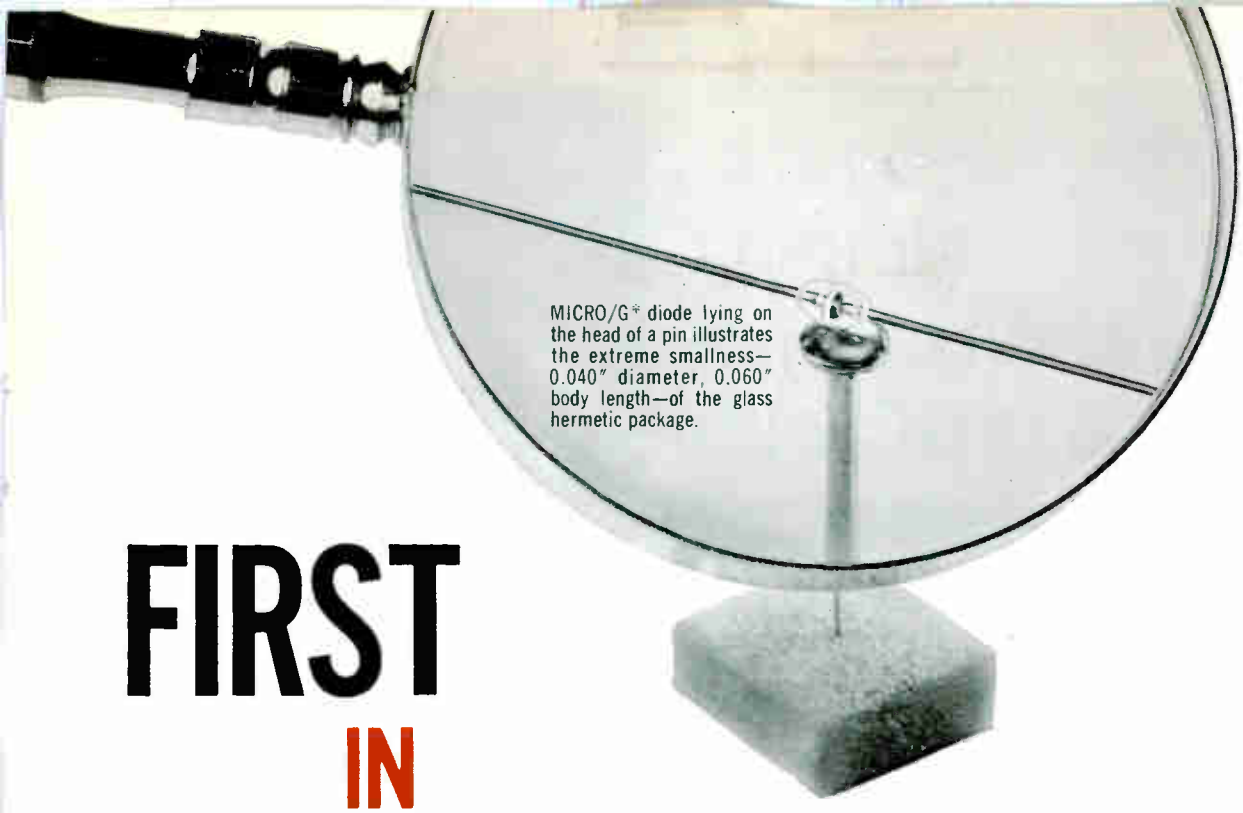
ARGENTINA will produce solar-cell operated radios and telephones. Production will be started this year by Industries Plasticas y Electronicas de Cordoba (IPEC) under licensing arrangement with Hoffman.

NASA last week authorized its field centers to step up hiring of qualified scientists and engineers. Purpose: fill vacancies and meet future needs.

ADDRESSOGRAPH-MULTIGRAPH CORP. will supply eight scanners and 26,000 imprinters to Gulf Oil Corp., which is automating its consumer credit card purchasing operations.

RCA'S Electronics Products Division, Camden, N. J., gets $3.2-million Air Force contract to develop a communications and data subsystem for Dynasoar project.

AUTONETICS Division of North American receives $126-million Air Force contract for continuation of work on guidance and control subsystems for Minuteman missile. Contract calls for design, development and prototype fabrication and test of the subsystems in developmental test quantities.



MICRO/G* diode lying on the head of a pin illustrates the extreme smallness—0.040″ diameter, 0.060″ body length—of the glass hermetic package.

FIRST IN A NEW GENERATION OF SILICON DIODES

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MICRO G*

MESA DIODES FOR YOUR COMPUTER APPLICATIONS

New *MICRO G* diodes — smaller in diameter than the head of a pin — give you electrical characteristics equal or superior to those of conventional-size computer diodes . . . in 1/50 the volume! ● The TI-2 and TI-6 capitalize on diffused silicon mesa wafers whose surfaces are *oxide-passivated* for optimum stability and reliability. The solid construction and extreme simplicity of the smallest hermetic computer microdiodes in the industry represent a revolutionary achievement in high-density packaging. ● *MICRO/G* diodes are priced competitively with their larger counterparts . . . contact your authorized Texas Instruments distributor or nearest TI Sales Office for evaluation samples today.

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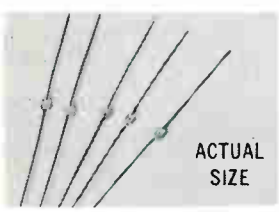
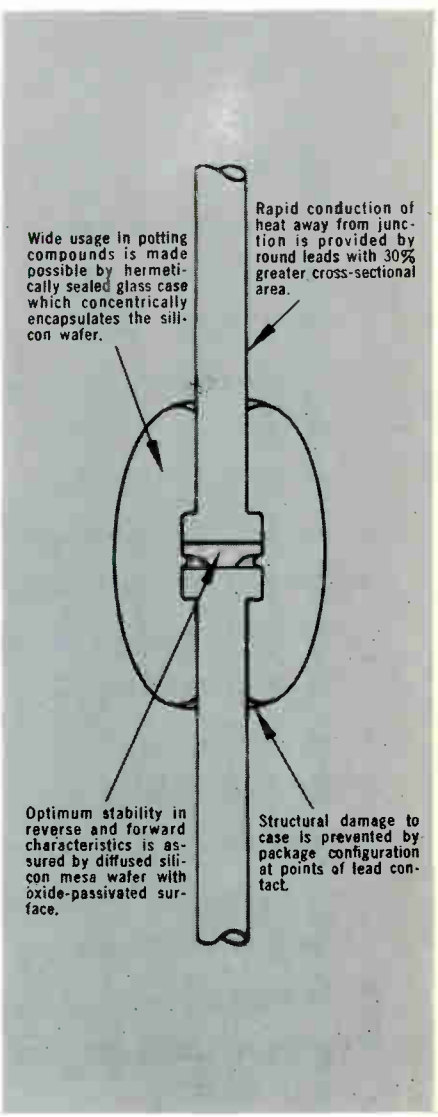


ACTUAL SIZE

MAXIMUM RATINGS	TI-2	TI-6	UNITS
V_F Fwd. Voltage Drop at 25°C	1 at I_F=10 ma	1 at I_F=5 ma	v
C Capacitance at V_R=0 Vdc at 25°C	4	10	μμf
I_R Reverse Current at 10 v at 25°C	0.025	1.0	μa
t_{rr} Reverse Recovery Time (10 ma I_F, 10 ma I_R Recovery to 1 ma reverse)	10	100	nsecs
V_R Reverse Voltage	40	20	v



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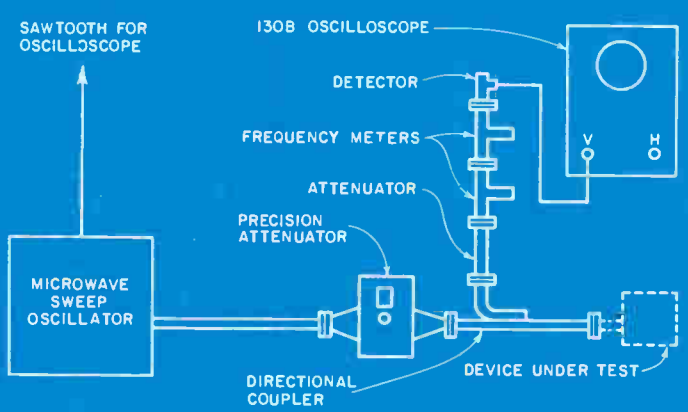
Speed, simplify measurements 1.0 to 18.0 GC with



VERSATILE hp MICROWAVE SWEEP OSCILLATORS

- Sweep full band, or any part
- Sawtooth output drives scope or recorder
- All electronic; no mechanical sweep
- Output level over entire frequency range
- Direct reading
- Independently adjustable frequency, sweep range, sweep rate controls

Equipment arrangement for automatically displaying magnitude of reflection from device under test.

hp Dependable, quality instruments

Hewlett-Packard Electronic Sweep Oscillators are precision measuring tools deliberately designed to give you simpler, faster microwave measurements. Six models are provided, covering frequencies 1.0 to 18.0 GC as follows: Model 682C, 1.0 to 2.0 GC; Model 683C, 2.0 to 4.0 GC; Model 684C, 4.0 to 8.1 GC; Model HO1 686C, 7 to 11 GC; Model 686C, 8.2 to 12.4 GC, and Model 687C, 12.4 to 18.0 GC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. Each oscillator provides a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the hp sweep oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the hp sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Leveled Output

All models provide leveled power output over their entire swept frequency ranges. An open-loop leveler is built into each instrument and provides leveled output without external equipment and at no extra cost. The leveler, which controls voltage on the grid of the backward wave oscillator tube, can be switched out of the circuit by means of a front panel control. Power variation over entire range: 682C, 683C $< \pm 1.5$ db; 684C $< \pm 2$ db; 686C $< \pm 1.25$ db; HO1 686C $< \pm 1.5$ db; 687C $< \pm 1.5$ db.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the hp sweep oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as hp 130B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip-chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your hp field engineer. Detailed discussions of these methods are also contained in the hp Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

3188

TYPICAL SPECIFICATIONS

Below are specifications for 686C Sweep Oscillator, 8.2 to 12.4 GC. Specifications for 682C, 683C, 684C, HO1 686C and 687C (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 GC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 1.25 db over entire 8.2-12.4 GC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 GC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 GC/sec.

Sweep Time: Determined by sweep range and rate; from 0.0139 to 139 seconds over full-band.

Sweep Output: Approx. + 25-volt peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level $\pm$ 1 db.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: + 10 volts or more, 5 millisecond maximum duration.

External FM: Approx. 150 v peak-to-peak to modulate full frequency range.

General

Output Connector: Waveguide cover flange (686C, 687C); Type N, female (682C, 683C, 684C).

Sweep Width: Accuracy, $\pm$ 10% for full band sweep. + 25%-15% or $\pm$ 3 MC, whichever is greater, for other calibrated sweeps.

Linearity: Half-voltage point of sweep output occurs within 5% of mid-frequency.

Power Requirements: 115/230 volts $\pm$ 10%, 50/60 cps; approximately 540 watts.

Price:

hp 682C (1.0 to 2.0 GC)	$3,090.00
hp 683C (2.0 to 4.0 GC)	3,000.00
hp 684C (4.0 to 8.1 GC)	2,900.00
hp 686C (8.2 to 12.4 GC)	2,900.00
hp HO1 686C (7.0 to 11.0 GC)	3,000.00
hp 687C (12.4 to 18.0 GC)	3,400.00

(Prices above are f.o.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

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WASHINGTON OUTLOOK

THE PENTAGON plans to set up a Defense Electronics Management Center to consolidate procurement and other supply management tasks for hundreds of thousands of electronics parts now bought and managed by several military supply agencies. The scheme will go far beyond the recent consolidation of electron-tube buying, will probably include determination of requirements, warehousing, distribution and the like.

The specific items to be included in the unified supply plan have yet to be designated. But a staff proposal calls for management of 650,000 items that now have an inventory value of about $1 billion. Examples: resistors, capacitors, connectors, crystals, coils, transformers, antennas.

Asst. Defense Secretary Morris says "The precise form of integrated management to be applied to (electronics) is not yet clear, but some form . . . is a certainty."

SOME $320-MILLION worth of electronics-laden McDonnell F-101B fighter-interceptor and Lockheed F-104G (photo) tactical fighter aircraft will be built under a new U.S.-Canadian agreement to modernize the RCAF and NATO Air Forces. General Dynamics' Canadair div. will be licensed to build the F-104G air-frames in Canada.

Major electronics subcontractors on the F-104G: RCA, Autonetics, Computer Devices of Canada, Hazeltine, ITT, GE and Litton Industries. Major electronics suppliers on the F-101B: Hughes, Minneapolis-Honeywell, Eclipse Pioneer and Kearfott.

THE DEFENSE DEPARTMENT has adopted a new procurement procedure known as two-step formal advertising that combines the benefits of negotiated contracting and open advertised bidding for purchase of equipment where precise design is not as important as specific performance. In the past two years, the Air Force has used the scheme experimentally to buy some $70 million worth of equipment, mostly electronics. Now the Pentagon has approved it for general use by the other services.

In the first step, bidders are invited to submit designs to meet specified performance criteria. No price or cost estimate is sought. The contracting agency examines the designs, approving those that appear to provide an item with desired performance. Bidders with approved designs submit sealed bids on their proposals. The contract then goes to the lowest bidder.

U. S. ARMY Signal Supply Agency will meet next week (June 28) in Philadelphia with small contractors from the Eastern states to discuss how smaller electronic firms can get a greater share of military business. Similar conferences will be held next month in Pasadena, Calif., and Chicago for contractors from other parts of the country.

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TYPE RS DYNOGRAPH

completely transistorized

2 channel rack or portable mounting

unmatched accuracy and versatility

25 years ago Offner invented the world's first Direct-Writing Oscillograph.

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Microvolt sensitivity, unmatched accuracy and compact design are combined with exceptional versatility in this completely new two channel Type RS Dynograph.

All-transistorized, table or rack mounted, conveniently carried for portable use, the Type RS Dynograph provides the same exceptional performance specifications as the Offner Type R Dynograph. Write for complete details.

Sensitivity: With preamplifiers, 10 microvolts per cm to 50 volts per cm.

Warm-up: Instantaneous.

Drift: One microvolt per hour pen drift at maximum sensitivity.

Ambient Temperature Range: —20° to +60° C.

Frequency Response: Within 10% to 150 cps, and 20% to beyond 200 cps.

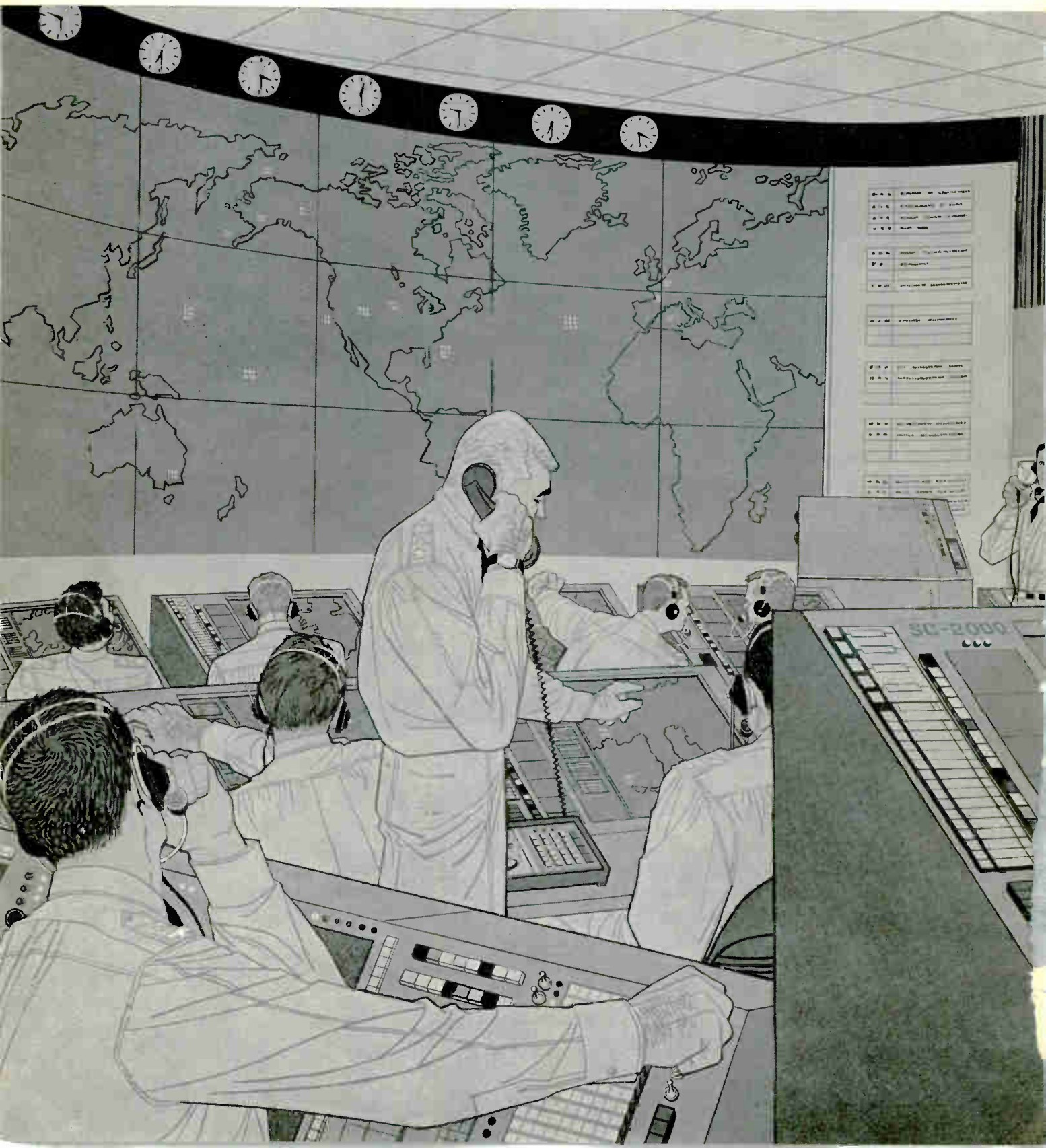
Recording Media: Rectilinear Heat or Electric, Curvilinear ink or electric, easily converted.

Deflection Time: 2.5 MS with preamplifiers, 1.5 MS without.

OFFNER ELECTRONICS INC.

3900 River Road, Schiller Park, Ill.
(Suburb of Chicago)

Less than 2 seconds from computer to large



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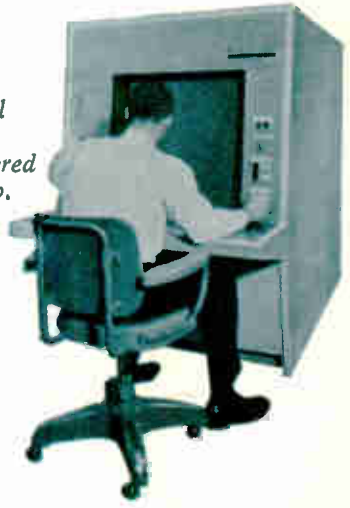
screen display WITHOUT DARKENING THE ROOM!

The new, advanced S-C 2000 bright display system developed by General Dynamics/ Electronics produces an entire large screen display less than two seconds after data are transmitted from the computer. The unique yet simple principle of the S-C 2000 results in high-contrast storage displays with unsurpassed brightness and resolution for information presentation on both console and large screens.

The S-C 2000 will display both video and alphanumeric data of all kinds simultaneously with any type of overlay. Display information need be transmitted only once from the data source owing to the inherent storage capability of the S-C 2000. The unit also provides both fail-safe retention of data and various types of permanent hard copy. Completely dry processing is incorporated with data rates of 40,000 separate characters per second. Scale changing, category commands and display selection are accomplished at the control console, without interrupting the computer.

A capability exists for seven color displays or data may be viewed as white against black or black against white. Resolution is 2000 lines on each axis. The S-C 2000 was developed under the auspices of the U. S. Air Force and Mitre Corp. If your requirements include computer display systems, we invite you to write for more information on the S-C 2000, a product of the company that produced the display control center for Project Mercury, General Dynamics/ Electronics, Information Technology Division, Dept. B-60, Box 2449, San Diego 12, California, or contact the representative in your area.



The first developmental S-C 2000 console delivered to Mitre Corp.

GD

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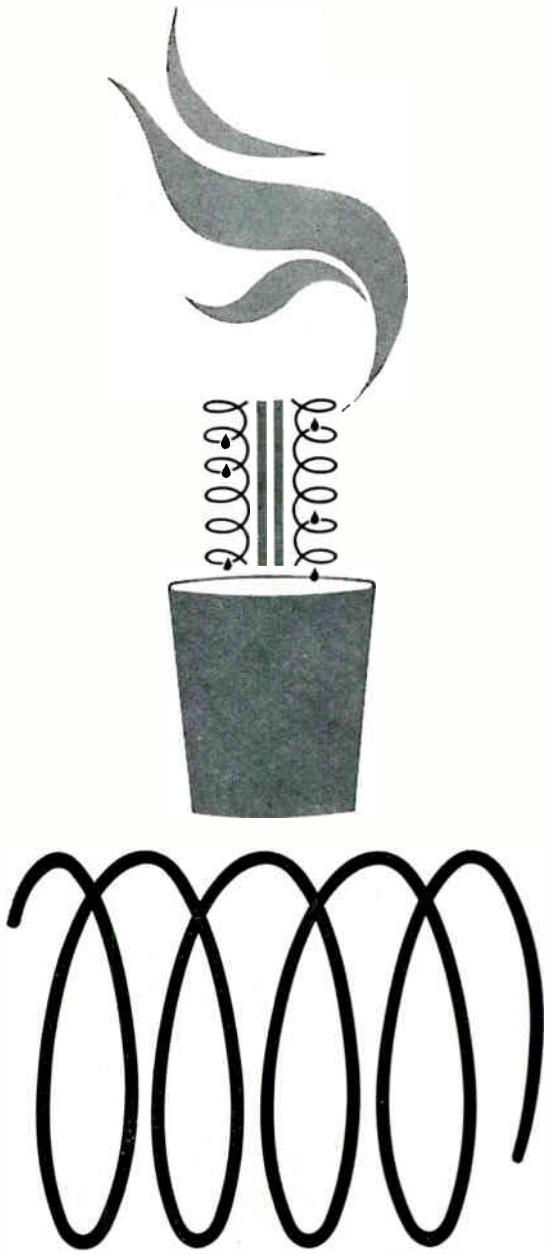
CIRCLE 17 ON READER SERVICE CARD



IN CLASS F POLYESTER MAGNET WIRE, SPECIFY ANATHERM-D FOR IMPROVED HEAT SHOCK RESISTANCE, VARNISHABILITY AND UNEXCELLED WINDABILITY

Anaconda has made important improvements in the heat shock resistance, windability, and solvent resistance of ordinary polyester magnet wire. The result is Anatherm-D, a Class F magnet wire with high thermal stability (155C) ■ High abrasion resistance ■ Excellent flexibility ■ High dielectric strength ■ Superior heat shock resistance ■ Unexcelled windability ■

IDEAL FOR ARMATURES AND FIELD WINDINGS. These improvements over standard polyester wires make Anatherm-D an outstanding choice for motor armatures and field windings, random- and precision-wound coils, specialty windings requiring high temperature resistance, and encapsulated coils.

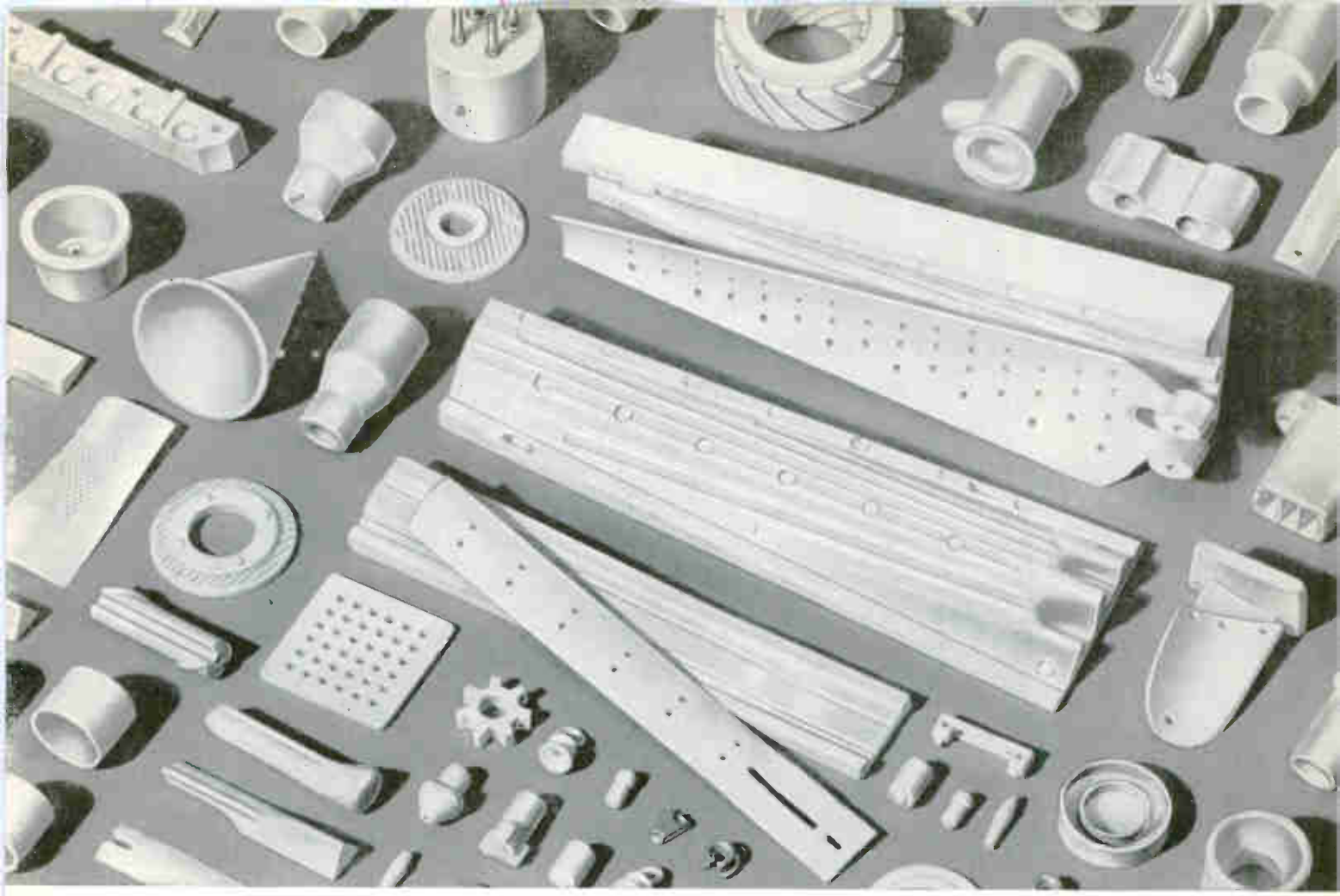
2-FILM CONSTRUCTION MAKES THE DIFFERENCE. The improved performance of Anatherm-D results from its two-film construction: an overcoat of special terephthalate polyester applied over a base film of Anatherm (the industry's first Class F film-coated magnet wire). The outer film contributes outstanding windability and protection against heat shock and mechanical stress.

CONFORMS TO NEMA AND MIL SPECS. Anatherm-D magnet wire meets all requirements of Spec MIL-W-583B for Class 155 Types L, L2, L3, and L4. It's available in all sizes of round, square and rectangular, with single, heavy, triple and quadruple film additions, all conforming with NEMA specifications. Anatherm-D is available in all standard Anaconda packages: spools, pails, reels and drums. For prices, technical data and application information contact Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York, Department EFL-1-E. 6137

ASK THE MAN FROM

ANACONDA®

FOR ANATHERM-D CLASS F POLYESTER MAGNET WIRE



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internal and external, formed in one operation to close tolerances in

AlSiMag® CERAMICS

NEW SHAPES NOW PRACTICAL

Technical ceramic parts formerly impossible or available only by expensive machining and grinding are now practical and can be produced in volume to close tolerances and with great uniformity. They include complex and compound curves, thin walls and other difficult design features. This injection molding process is particularly suited to volume production which readily permits amortization of initial tooling costs.

MATERIALS

AlSiMag 614 (High Alumina) and AlSiMag 704 (Porous and Leachable) have found widest use. Other AlSiMag ceramic compositions are available. See Property Chart, sent on request.

APPLICATIONS

include but are not limited to:

Electronic and Electrical, such as conical micro-wave tube windows, envelopes, complex internal insulators, cups, encapsulating devices, semi-conductor assembly boats and plugs.

High Temperature, Mechanical and Heat Shock uses such as welding nozzles.

Precision Investment Casting cores of great dimensional accuracy.

Guides for wire and textile machinery.

The use of these AlSiMag ceramics is indicated when high frequencies, high temperatures, heat shock, chemical attack or mechanical wear are involved.

EXPERIENCE

More than two years of steadily increased production from this equipment has given us practical experience which enables us to promptly and accurately answer most inquiries involving complex and difficult shapes. Send blue prints or sketches. Chances are that your "impossible" designs are now practical in AlSiMag ceramics.

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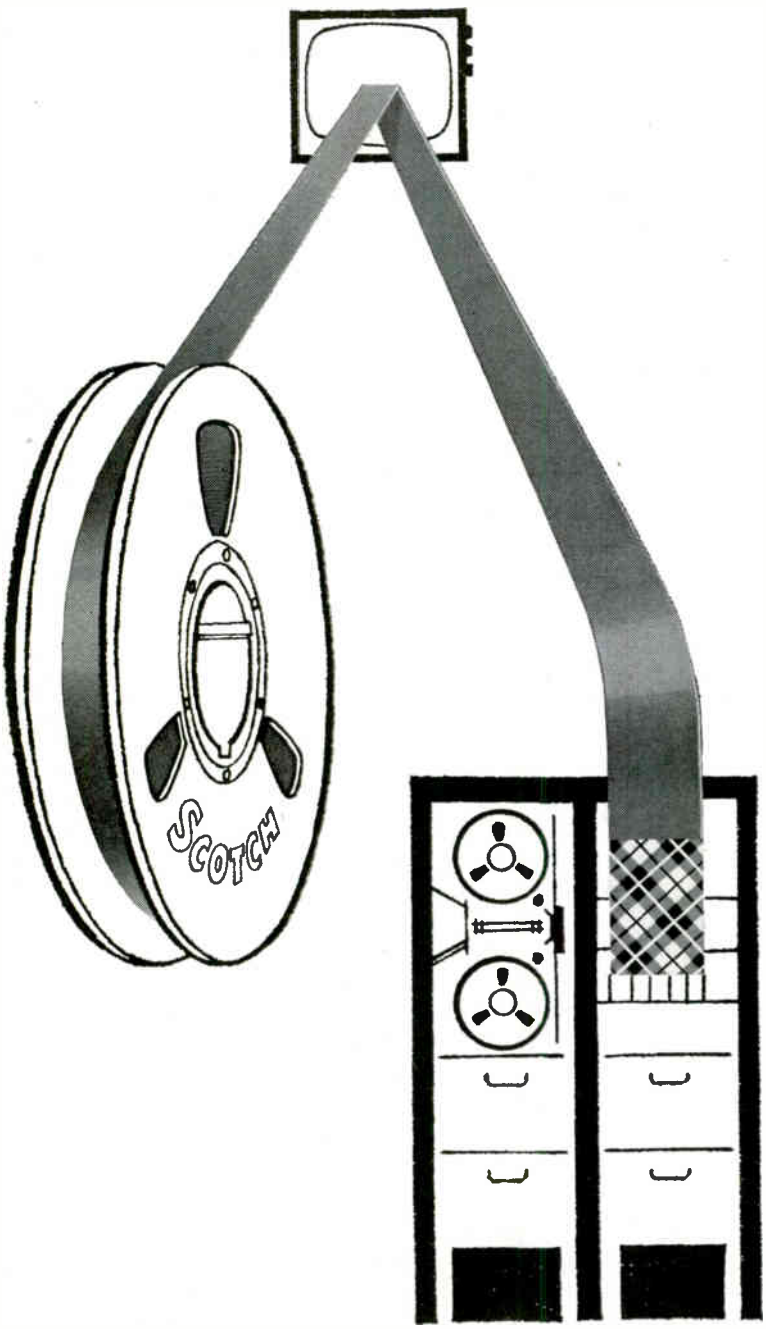
THE TAPE THAT CHANGED TV FOR ALL TIME

leads you right to rugged
SCOTCH® BRAND Heavy Duty Tape



THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250°F.

The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 498 and 499.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 457, 458 and 459; High Output Tape 428; Sandwich Tapes 488 and 489; and Standard Tapes 403 and 408.

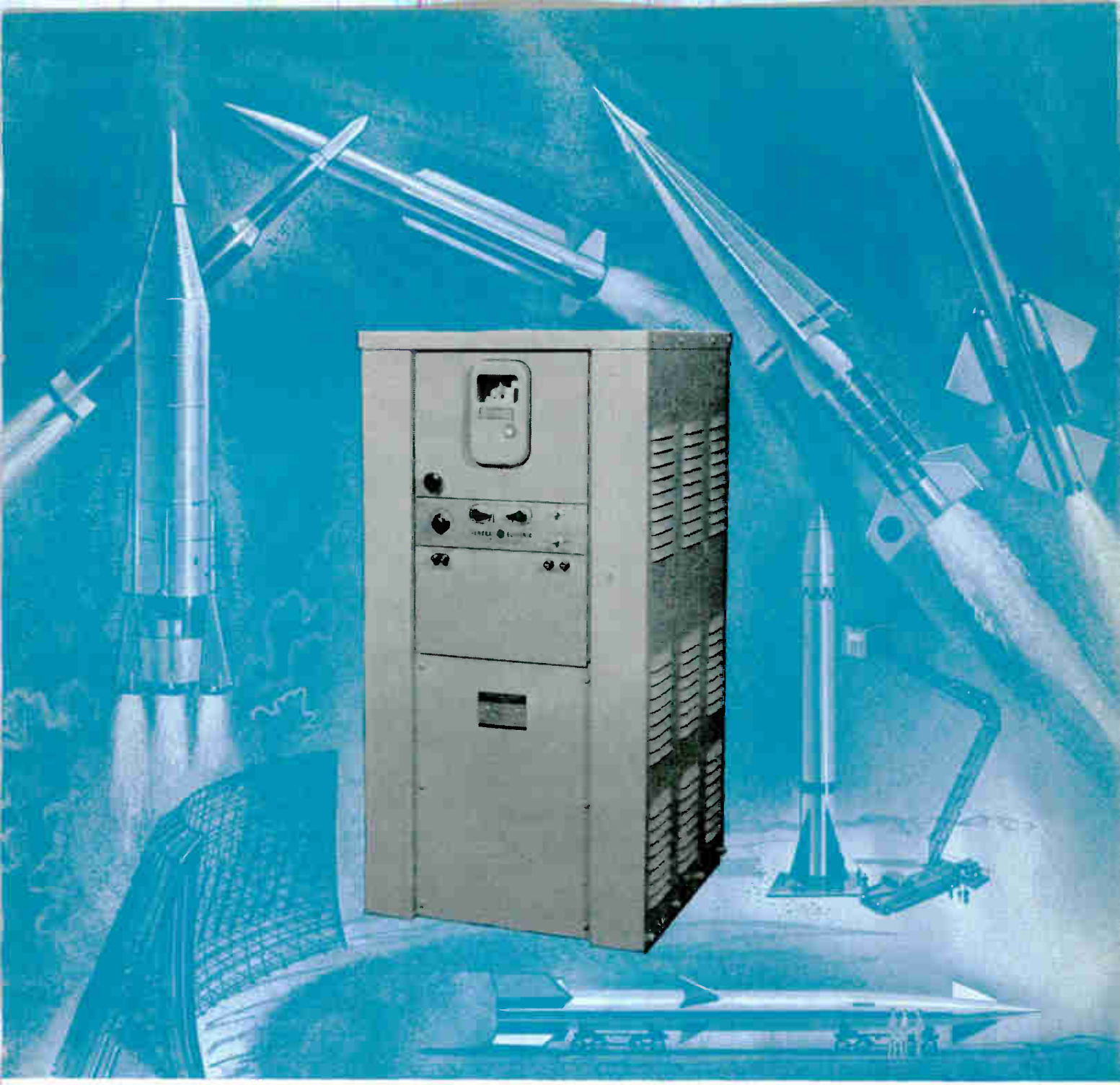
Your 3M Representative is close at hand in all major cities. For more information, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

REG U.S. PAT. OFF. SCOTCH BRAND MAGNETIC TAPE

FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY



GENERAL ELECTRIC INDUCTROL® VOLTAGE REGULATORS . . .

Where reliable voltage control is a MUST

Atlas, BMEWS, Bomarc, Corporal, Minuteman, Nike-Hercules, Nike-Zeus, Tartar—here, reliability may mean survival . . . and dependable voltage control is a *must*. That's one reason why General Electric Inductrol voltage regulators are an integral part of *all* these systems.

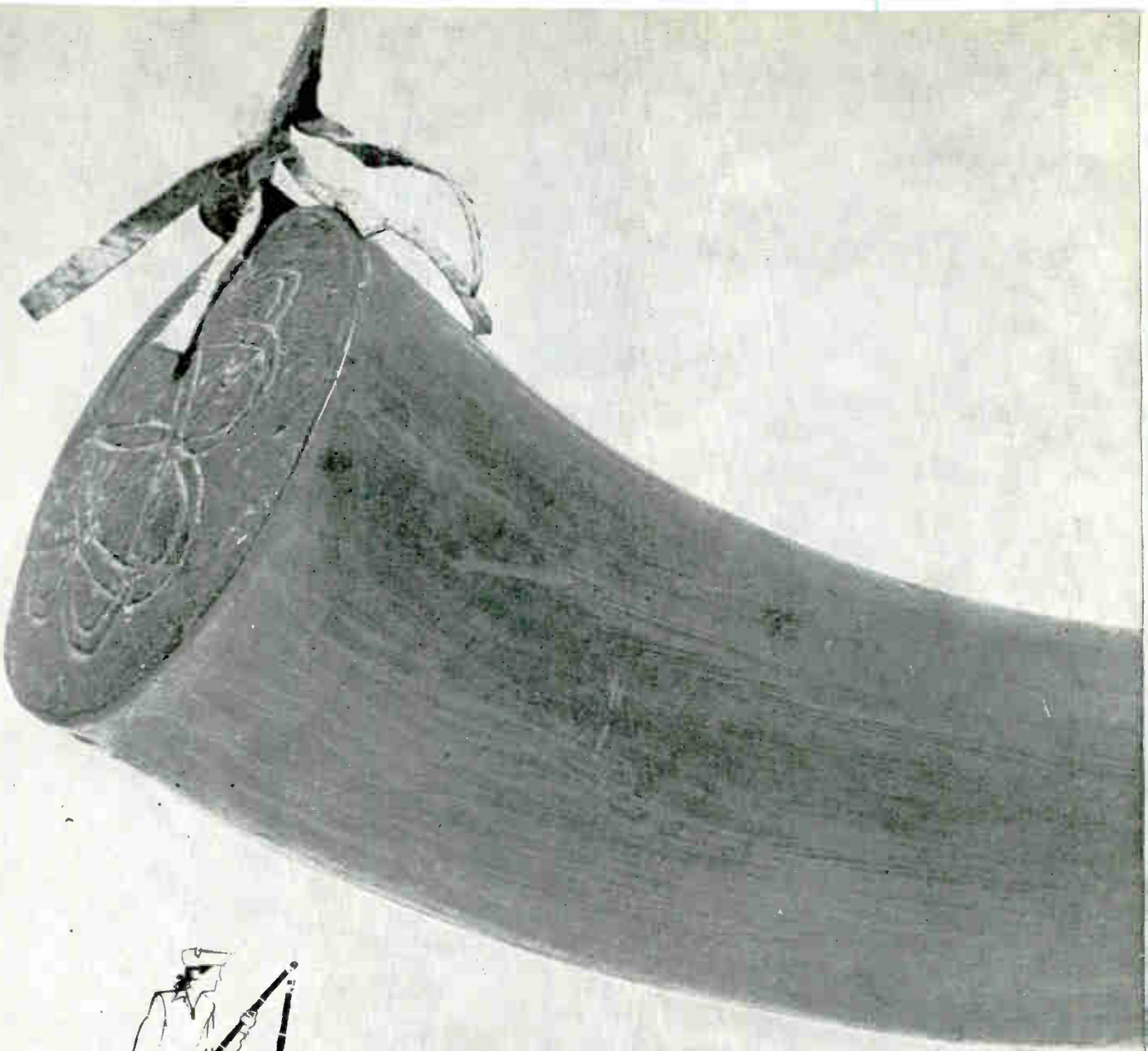
This reliability can be vitally important to *your* application, too . . . whatever your voltage control requirements. Reliability is inherent in the simple induction principle of this advanced regulator design. There are no tubes to replace, no sliding brushes to wear out, no associated d-c power supply to maintain.

For full information, see your nearby G-E Sales Engineer. Or write for GEC-1450 to General Electric Co., Section 457-05, Schenectady 5, N. Y. *Voltage Regulator Products Section, Pittsfield, Mass.*

INDUCTROL REGULATOR FEATURES:

- Automatic ±1% control accuracy
- Stepless, drift-free control
- 100% overload capacity up to 1 hour
- 97 to over 99% efficiency
- Load, power-factor and frequency compensated
- No harmful waveform distortion
- Rugged, compact construction

GENERAL ELECTRIC



Instant Defense

The Minuteman at Lexington and Concord was ready at a moment's notice to defend his home. Today's Minuteman, a solid fuel, 6325-mile range ICBM—launched from underground silos or railroad cars—can be readied in seconds, to bring a nuclear war home to any aggressor! □

Before and during its successful firing last February, Minuteman was tested on the ground, in transit, in trajectory. Much of this testing—measuring, analyzing, controlling, recording—was done with Consolidated Electrodynamics Corporation instruments. □ Transducers for test units of Minuteman are made by Consolidated. CEC oscillographs are used throughout FM/telemetry, PCM, and various ground support stations for the test program. □ The three data acquisition systems designed for road testing the first-stage rocket engine have relied on CEC print-out oscillographs to record accelerations. Various ground-test pressure transducers and

all low-frequency accelerometers used in first-stage propulsion system tests also were made by CEC. □ Consolidated instruments played an important role in road tests to demonstrate that the third-stage rocket engine could be transported by truck from Utah to such cities as Denver, Las Vegas, and Seattle, and returned to Utah and fired successfully. Three test trucks were equipped with instrumentation to measure shock, vibration, and engine environment. Mounted in the trucks were three CEC mobile instrumentation systems, each made up of a recording oscillograph, two carrier amplifiers, a tape recorder, and Consolidated's newest strain gage accelerometers. Purpose of the tests was to determine if handling and cradling of the engine could be improved and if strain and stress on motor cases were excessive. □ In mobility tests of Minuteman units carried by train, CEC provided all of the accelerometers used to determine the extent of shock and vibration to which the missile is subjected. □ Partners in this important defense project are Boeing Airplane Co., Space Technology Laboratories, Autonetics Division of North American, Thiokol Chemical Corporation, Hercules Powder Company, Aerojet-General Corporation, and Avco Corporation. □ CEC knows. These companies know. The world knows. Keep America's powder horns filled, maintain Instant Defense, and no enemy will dare to attack. That's the promise of the Minuteman.

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RACE TO THE MOON: A BIGGER MARKET

By JOHN F. MASON
Associate Editor

THE RACE TO BEAT THE Russians to the moon has an entry fee of $20 to $40 billion.

President Kennedy has asked Congress and the American people to decide what value we place on being first. And after establishing such a viewpoint, to accept the cost.

Whether Congress will downgrade the importance of being first because of the staggering cost estimated by the President, remains to be seen.

Chances are good that the program will be pushed forward, although possibly short of the all-out acceleration the President recommended.

The National Aeronautics and Space Administration has presented this plan to the Senate:

The Mercury project as such will terminate after the first manned three-orbit flight. The remaining Mercury capsules will be modified for longer flights and become part of the Apollo program. A total of $63.9 million is needed for this conversion. To prepare for these longer flights, up to 14 days, $16.6 million is requested for biomedical research to study effects of weightlessness and radiation for long periods.

On July 18, NASA will begin a three-day industry briefing on the command-center module for the Apollo spacecraft. Invitations to bid will be sent out by Aug. 1. A total of $52 million is requested to get these contracts moving.

High-speed reentry research on materials will involve sounding rocket tests and cost $27.5 million.

For Ranger, Surveyor and Prospector, the three unmanned lunar craft, there will be more flights than previously planned, increased frequency of flights and more scientific instruments will be carried.

NASA's previous request for Ranger was $30.9 million. This is now upped to $64.8 million. Original request for Surveyor was $32.3 million, is now increased to $53.1 million. Prospector's original $1 million is increased to $2.4 million.

First of the unmanned craft that will be sent to the moon is Ranger B. The 750-lb craft will monitor radioactivity and televise the lunar surface before destroying itself in a 5,000-mph impact. A 300-lb capsule is designed to survive the crash. It contains 100 lb of instrumentation: a single-axis seismometer, temperature-recording devices, telemetry and power supply and will be detached on command by an altimeter some 20 to 25 miles above the moon. A retrorocket will slow its impact speed to less than 300 mph. The instrument package is expected to remain active up to three months.

During early phases of the flight, attitude control jets will maintain three-axes stabilization to keep the solar panels toward the sun and the high-gain antenna pointed toward the earth. Course will be maintained by radar tracking and midcourse retrorocket firings.

During the last 10 hours of the 66-hour flight, the gamma-ray spectrometer will monitor radioactivity in the lunar surface to provide clues to the lunar formation.

As the spacecraft approaches the moon's surface, it will orient itself with its instrumentation pointing toward the surface. At about 2,000 miles the vidicon telescope will be activated and take approximately 100 pictures prior to firing the capsule retrorocket at slightly under 20 miles altitude. The first picture will have a field of view 25 miles square with a resolution of between ten and 20 feet.

Prior to the Ranger-B rough moon landing shots, there will be two test missions that call for putting Ranger-A vehicles in highly elliptical earth orbits, the second to fly close to the moon. The program consisting of more than five launchings will begin the latter half of this year and be completed 12 months later.

The Jet Propulsion Laboratory is responsible for the design and operation of the spacecraft, including integration of scientific instruments, and for the deep-space instrumentation facility that provides post-injection tracking and data handling after craft is in orbit. The preparation and operation of the rockets and all associated equipment up to the point of injection is the responsibility of the Marshall Space Flight Center.

Ford Motor's Aeronutronic div. is building the lunar capsules. The altimeter was built by Ryan.

After Ranger, comes Surveyor, a series of more than seven craft, to begin in 1963. Some Surveyors will be sent into a precise orbit around the moon to take tv pictures of specific predetermined areas of its surface. Others will soft land (5 to 10 mph) on the moon.

Propelled by a three-stage Atlas-Centaur booster, Surveyors will weigh about 2,500 lb at injection, land a 750-lb package on the moon, of which 500 lb will be communication equipment, structure and temperature control instrumentation. The remaining 250 lb will be scientific instruments, including several tv cameras, sensitive seismometer, magnetometer, gravitometer, drill, spectrometers to analyze the chemical composition of surface and subsurface samples down to five feet, radiation detection devices for the lunar atmosphere and surface.

Hughes is building the Surveyor craft for JPL.

Next step is Prospector, a soft-land craft that will crawl around on the moon's surface by 1966. Although in-house studies of Prospector are continuing at JPL, it is conceivable that the acceleration of the manned Apollo exploration

FOR US?

project will succeed to the point of eclipsing the need for Prospector. However, Prospector will remain an active project for the time being.

Plans for Prospector call for a 15,000-lb craft, boosted by a Saturn vehicle. Guided by a command center on earth, the craft will crawl around on the lunar surface taking samples, mapping, making pictures and doing almost everything a man can do. NASA envisions later Prospectors returning to the earth with samples or landing supplies and equipment on the moon in support of manned stations.

The three-step Apollo program calls for earth orbits, circumlunar and finally a moon-landing and return. To achieve this multiplicity of missions, the craft will use modular design. First module is the command center to house the crew and serve as flight control center.

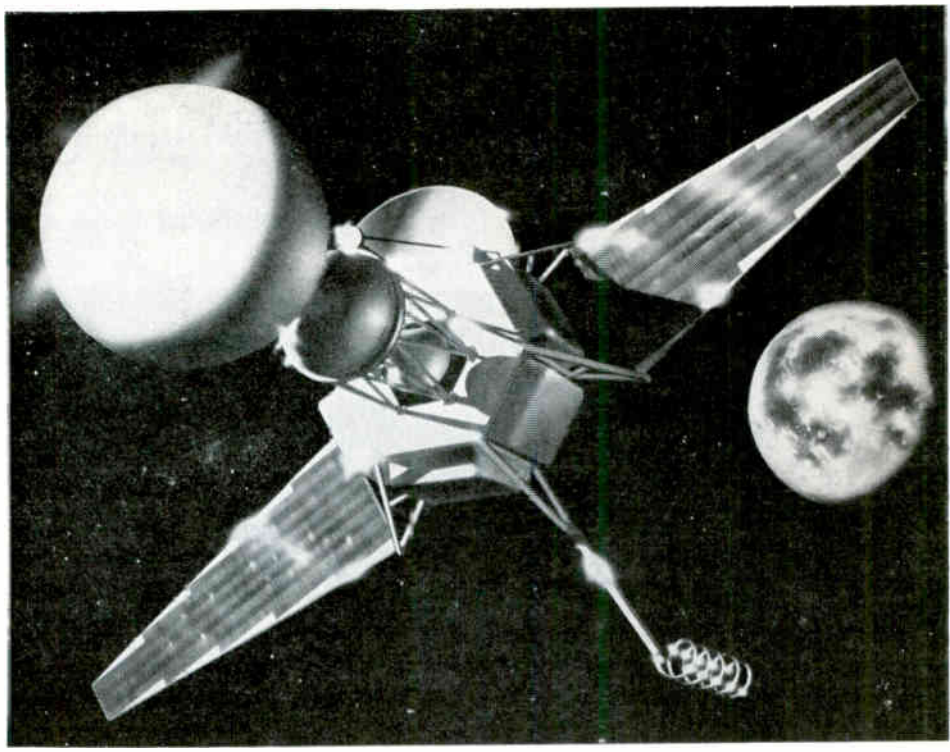
Second module is a propulsion unit to return the craft to earth, to maneuver in orbit and for orbital rendezvous; this module for circumlunar flights will provide midcourse and terminal guidance corrections or place the craft in orbit around the moon and eject it from that orbit to return to earth; for lunar landing, this module will be the take-off stage from the moon.

Third module is propulsion to decelerate the craft as it approaches the moon.

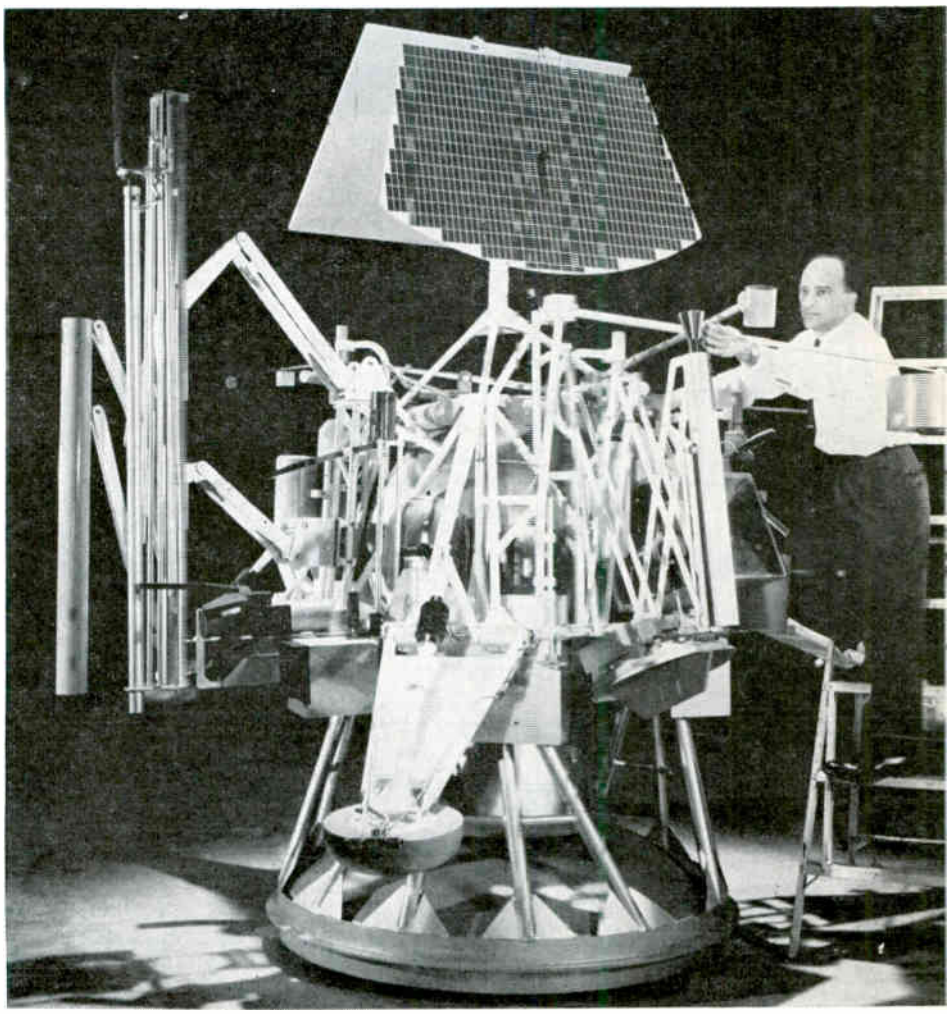
An additional module could be used for an earth-orbit mission to convert the craft to a laboratory.

Basis for industry briefing July 18 will be results of three study contracts completed in May by GE, Convair and Martin. Massachusetts Institute of Technology has a $100,000 contract for R&D and laboratory study of a guidance and navigation system for Apollo.

Martin has a $75,000 contract to study various booster vehicle designs for a manned transportation system to the moon.



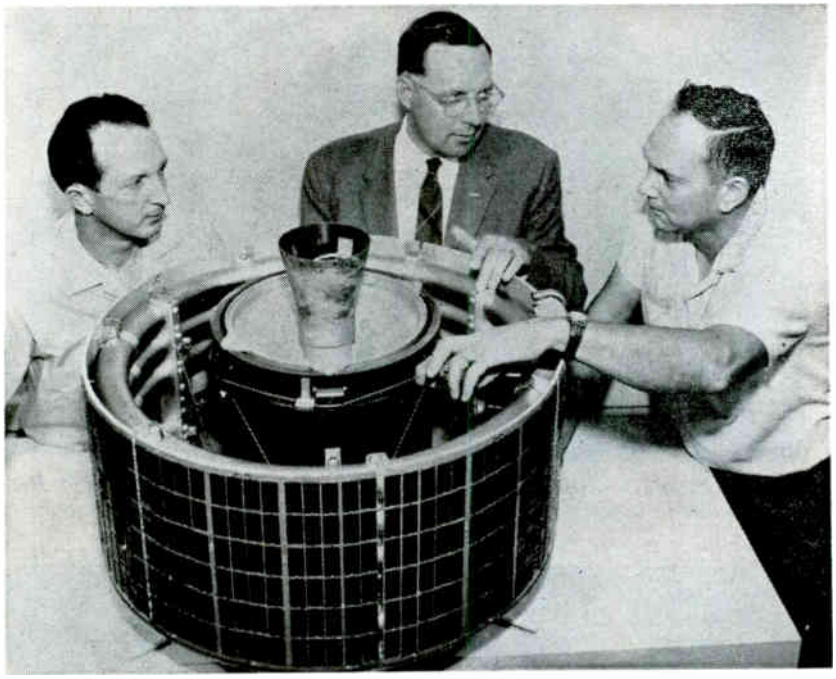
First U. S. instrument package to land on the moon will probably be Ford Motor's 300-lb capsule with seismometer, temperature recorder, telemetry



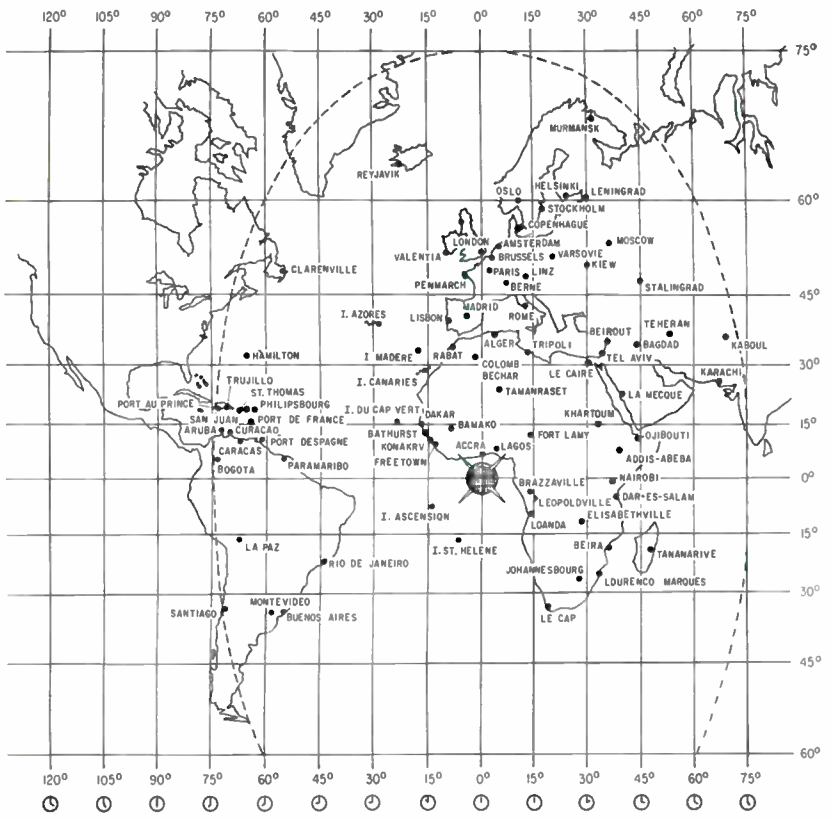
Second series of moon-landing craft will attempt to soft-land Hughes' Surveyor carrying tv cameras, earth and atmosphere measuring gear

Transistor Equatorial Satellite Studied For European-African Communications

By ARTHUR ERIKSON McGraw-Hill World News



Hughes Aircraft communications satellite



Satellite put into synchronized equatorial orbit would remain fixed with respect to earth, 22,400 miles above 0 deg latitude, 0 deg longitude. Dotted line shows where transmitting-receiving stations could be set up

PARIS—Moving into the spotlight for a day at the Paris Air Show, the French electronics industry proved the sky's no limit, technically speaking.

Compagnie Française Thomson-Houston, for example, signaled that it was ready to move into space communications. The company has teamed up with Hughes Aircraft to study the possibilities of adapting a communications satellite to European-African needs.

Under the plan, the 33-lb Hughes transistor satellite would be put in a synchronized equatorial orbit so that it would remain fixed with respect to the earth at a point some 22,400 miles above 0 deg latitude, 0 deg longitude.

In that position, the satellite would provide coverage for all of Europe, Africa and the Middle-East, plus part of South America. With that coverage, the two companies hope an international project can be set up.

Since this satellite communications system would be a link between a large number of places, design will have to be for a high number of low-capacity telephone channels, rather than the single high-capacity channel that a transoceanic link would need, the French-U. S. partners point out.

Ground-satellite transmission would be in the 460-Mc range, using single-sideband technique. For a 600-channel station, CFTH indicates, a 130-foot antenna and a 25 Kw peak-power transmitter would be needed; a 1 Kw transmitter would do for a four-channel station.

Satellite-ground transmission would be at 2,000 Mc with 23 Mc bandwidth. Ground station receivers, using parametric amplifiers with diodes at liquid-nitrogen temperature, would need excellent noise factors. CFTH, who is handling the design of the ground equipment, says total receiver noise temperature including noise picked up by the antenna, feeder losses and

noise in the parametric amplifiers can be held to 65 deg K or less.

There was evidence at the Air Show that French electronics manufacturers are moving ahead technically to keep up with the needs of the high-fly set.

The industry now is turning out annually some $61 million worth of electronic hardware for planes and ground stations. The trend is to smaller packages and better performance. To single out a few items:

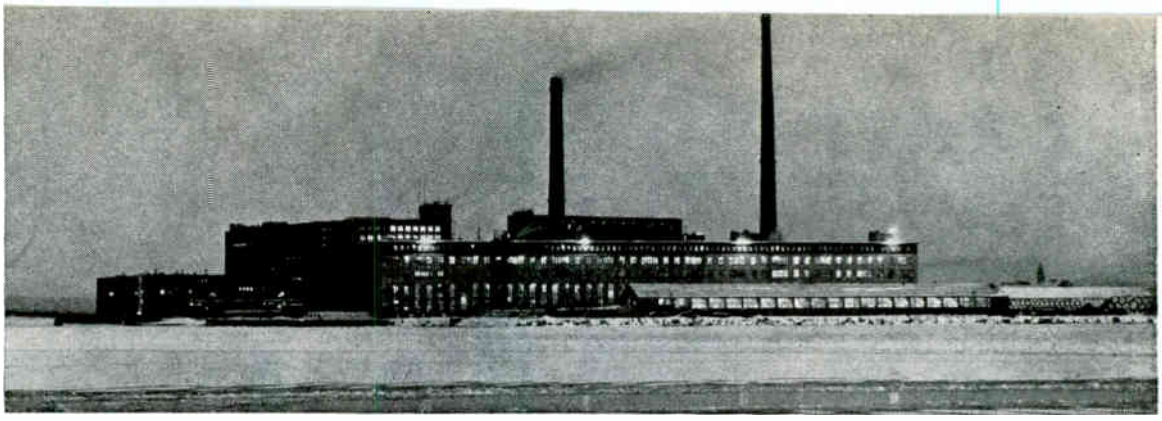
• SOCRAT (Société de Constructions Radiotéléphoniques) displayed an airborne uhf transmitter-receiver with 1,750 channels, announced that a 3,500-channel version was under development.

• TRT (Télécommunications Radioélectriques et Téléphoniques) showed a transistorized altimeter that operates on 10-cm wavelength, has an accuracy of ±1 foot at altitudes between 0 and 98 feet.

• SAT (Société Anonomye de Télécommunications) had at its booth a transistor infrared control system for ground-to-ground missiles. Control is accurate within 1 degree around the horizontal and vertical control axes at ranges to 9,800 feet. The system shifts from a wide control field, used over the first 1,500 feet until the missile steadies down, to a precision field that puts the missile on the target. Other performance details and circuits are classified.

• SACM (Société Alsaciene de Constructions Mécaniques) presented Peltier effect cooling plates that permit transistor operation in ambients to 150 deg C. One-watt versions keep the transistor base as much as 40 deg C below ambient; 5-watt versions provide temperature differentials to 60 deg C. For multiplier phototubes, cylindrical cooling elements have been developed.

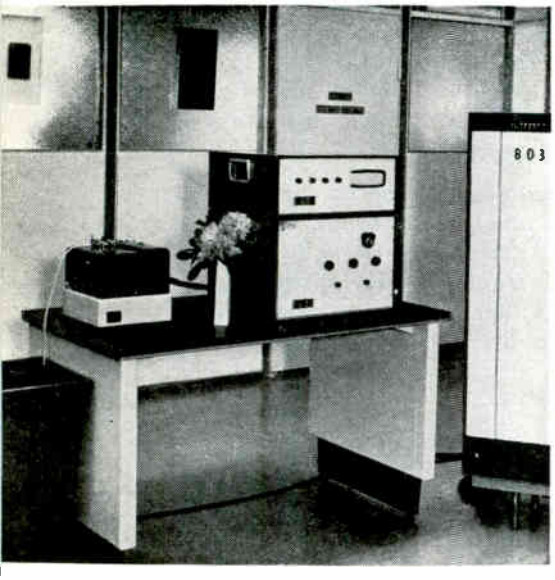
In other news: added hardware slated to go into service for Air France next year is an electronic reservation system now being installed in Paris. The equipment will store reservation data for more than 200 flights on which Paris has space quotas, indicate in less than five seconds if a booking can be made on any of the flights. One of the 130 reservation consoles was displayed by its maker, LMT (Le Matériel Téléphonique).



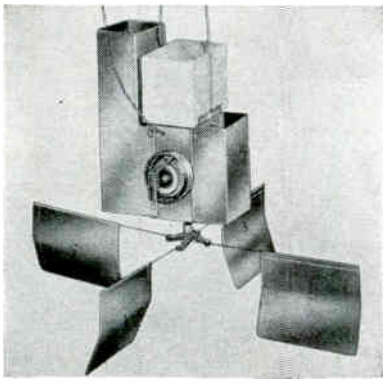
Finnish Cable Works at Salmisaari

ELECTRONICS IN FINLAND

By LANCE KEYWORTH
McGraw-Hill World News



Neutron - time - of - flight analyzer and data processing setup



A Vaisala radiosonde

HELSINKI—Until recently only one branch of the electronics industry existed in Finland to any important extent—radio and tv. Currently it is employing 2,000 people and showing an annual turnover of $13 million. Two percent of the production is exported.

Finland started construction of vhf radio networks in 1952, now has 45 stations. There are 16 tv stations, more under construction.

A feature common to the few Finnish companies so far manufacturing electronic equipment of other kinds is a high degree of specialization.

For example, Vaisala, Inc. concentrates largely on a radiosonde and associated ground equipment for measuring pressure, temperature, humidity, wind speed and direction in the upper atmosphere up to about 100,000 feet. About 97 percent of production is exported, to 18 countries.

Wallac, Inc. started in 1950 with automatic electronic humidity measuring and control equipment for the textile industry. The firm has since followed this with devices for remote heat control, instruments for air flow speed measuring and for measuring radioactivity. About one-third of the radioactivity monitoring instruments are exported.

The State Electrical Workshop was founded in 1945. Its radio department manufactures marine equipment, sound projection equipment, vhf radiophones.

It also makes detectors to find foreign bodies of metal in logs.

The radio research department now works under the State Institute for Technical Research. The main employer is the Defense Forces. The department has constructed an ionosphere sounder for the Post Office and instruments for the study of the Northern Lights and satellites.

In the spring of 1960, the Finnish Cable Works (annual turnover $50 million) established an Electronics Department.

The department has so far purchased a National Elliott 803 and a Siemens 2002 data processing machine. They serve the department, company, and outside customers.

Industry and the universities have supplied experts in applied mathematics, physics, electronics and industrial instrumentation and automation—a staff of 35 which is still increasing.

Early production of the electronics department comprises digital instruments of the computer type such as multi-channel pulse height analysers, neutron-time-of-flight analysers for nuclear research, recorders for measuring atmospheric radioactivity and metal content indicators. It also makes special instrumentation for measuring ballistic initial speeds and times of flight, a system equipped with vhf digital remote data transfer and receiving equipment.

The demands of defense have made it necessary to develop a Finnish electronics industry. Aside from defense needs, the demand for electronics equipment is now rising sharply so there is likelihood of expansion of the industry.

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Need Frequency Standards to 1 in 10^{11} ?

By GEORGE J. FLYNN
Associate Editor

"IS THERE a need for frequency standards accurate to one part in 10^{11}, or better?" The answer is "yes," according to audience responses during the general discussion session of the 15th annual Frequency Control Symposium.

"Is there an upper limit to coherent frequency multiplication?" If there is, it has not yet been reached. Coherent signals have already been multiplied up to the 300 Gc region. There is at least one attempt being made to multiply coherent red light up to blue light.

Radar returns from the planet Venus have a bandwidth of only two or three cps. If analysis of such narrow bandwidth signals is to be accomplished with reasonable speed and accuracy, the reference frequency must be stable to 0.1 cps. But 0.1 cps stability at a radar frequency of 10,000 Mc is one part in 10^{11}. This is one application for ultimate-stability frequency control.

Other applications for nearly absolute frequency stability are studies in cosmology, the Stark effect (electric field influence on the atomic hyperfine structure), studies of just how constant so-called atomic constants are, gravitational influences on satellites, and other studies.

In cosmology, for example, radio telescopes sperated by the diameter of the earth could be synchronized by precise clocks. The increase in resolution that could be obtained by this technique was indicated to be several orders of magnitude better than the best available today. Precise clocks in orbit is another way of mechanizing the concept of giant radio telescopes.

Another question was raised: Is it possible to have optical masers below infrared? An audience response indicated that masers should be possible from millimeter wavelength to visible light, and that a maser operating from 100 to 300 microns seemed feasible, using magnetic tuning.

Turning to the formal program of the conference, nearly half the papers dealt with advances in crystals and crystal control circuits. Frequency stability of one part in 10^9 and Qs greater than 8×10^7 were reported by D. L. Hammond of Hewlett-Packard. The stability approaches that of atomic standards but crystals do not depend on atomic resonance and thus suffer from aging.

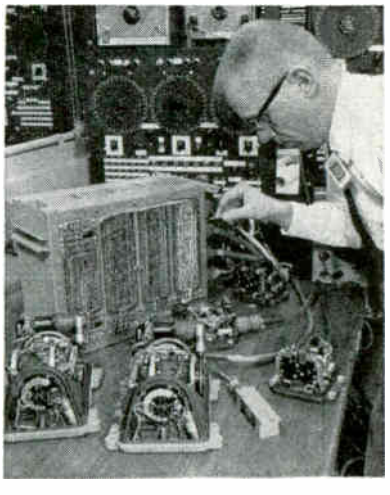
N. F. Ramsey of Harvard presented technical details on the "bouncing box" hydrogen clock. Original estimates of an ultimate accuracy of 1 part in 10^{15} have so far proved optimistic and indications now are for 1 part in 10^{13}. Verification of this result must wait until two clocks are in operation, and is expected some time this summer.

Total attendance at the conference was about 700, up 100 over last year, and included experts from England, Canada, West Germany, and The Netherlands.

Digital Computer Controls Fluid Catalytic Cracker

INSTALLATION of a digital computer system for automatic control of Standard Oil of California's fluid catalytic cracker is scheduled for

Mercury 'Pilot' Unit



Attitude stabilization and control system manufactured by Minneapolis-Honeywell for Mercury capsule uses five gyros, accelerometer and computer

completion sometime this summer.

An IBM designed computer built for Stan Cal at a cost of about $250,000 will control the catalytic cracker which accepts 40,000 barrels of fresh feed distillate daily.

A total of 75 points of information must be handled simultaneously by the computer system. Initially, rapid calculations will be made by the computer on an open-loop basis. Control loops will be closed one by one, until the fluid catalytic cracker is fully automatic.

Estimates indicate that only a two-percent increase in value of product is needed to make the project a success.

Most of the control system is in a small building at the refinery 100 feet from the cat cracker control room. The building contains transducers for converting hydraulic and pneumatic pressures into signals for the computer.

The 75 information points are scanned continuously at an average rate of 40 a minute. Information includes pressures, temperatures and flow rates, is stored in the computer's memory. Data is operated on by the computer, which contains a set of equations that extrapolate and determine how much control should be changed to improve performance without violating plant limits.

An optimization calculated using linear programming is made and a readout based on automatically timed calculations is accomplished every 15 to 20 minutes.

Tunable Swiss Radio Fits in Sunglasses

A MINIATURE transistor radio built into the ear shaft of sunglasses was announced recently by a Swiss manufacturer. The radio is tunable and highly selective; it has a daytime range of 40 miles.

The radio, developed by Montaphon-E.F. Kind of Zurich, conducts sound directly into the ear so that only the wearer hears the station. The radio's four transistors, crystal diode and ferrite antenna are in the ¼ × ½ in. shaft. The 1.3 v button-cell lasts 100 hours and a spare battery cell is provided in the other sunglass shaft.

ACADEMICALLY SPEAKING

Electronics Research Expands at UCLA

MICROWAVE tube research, solid state electronics, circuit research, microwave radiation and propagation are some fields of study that will be expanded by a $250,000-per-year contract granted to UCLA by the three armed services.

Donald O. Pederson, director of the university's Electronics Research Laboratory, says the new contract will enable every eligible graduate electronics student to receive financial support in the form of part-time salary, technical services or both.

CAREER GUIDANCE needs in electronics are being investigated by the Educational Coordinating Committee of the Electronic Industries Association. Prospective technical manpower shortage in the industry has prompted the committee to prepare a brochure to tell high school students of electronics career opportunities. Plans for publication and distribution are now being developed.

Four task forces are conducting studies and submitting recommendations to the EIA Board of Directors on all educational matters affecting our industry. Task force on Technical Manpower Requirements is chaired by Luke Noggle, Westinghouse; G. F. Maedel of RCA Institutes, Inc. heads up Curriculum Development; Methodology and Educational Equipment has Robert G. Frick, GE, as chairman; and Public Relations is led by Stanley Thea, Ruder & Finn, Inc., New York City PR firm.

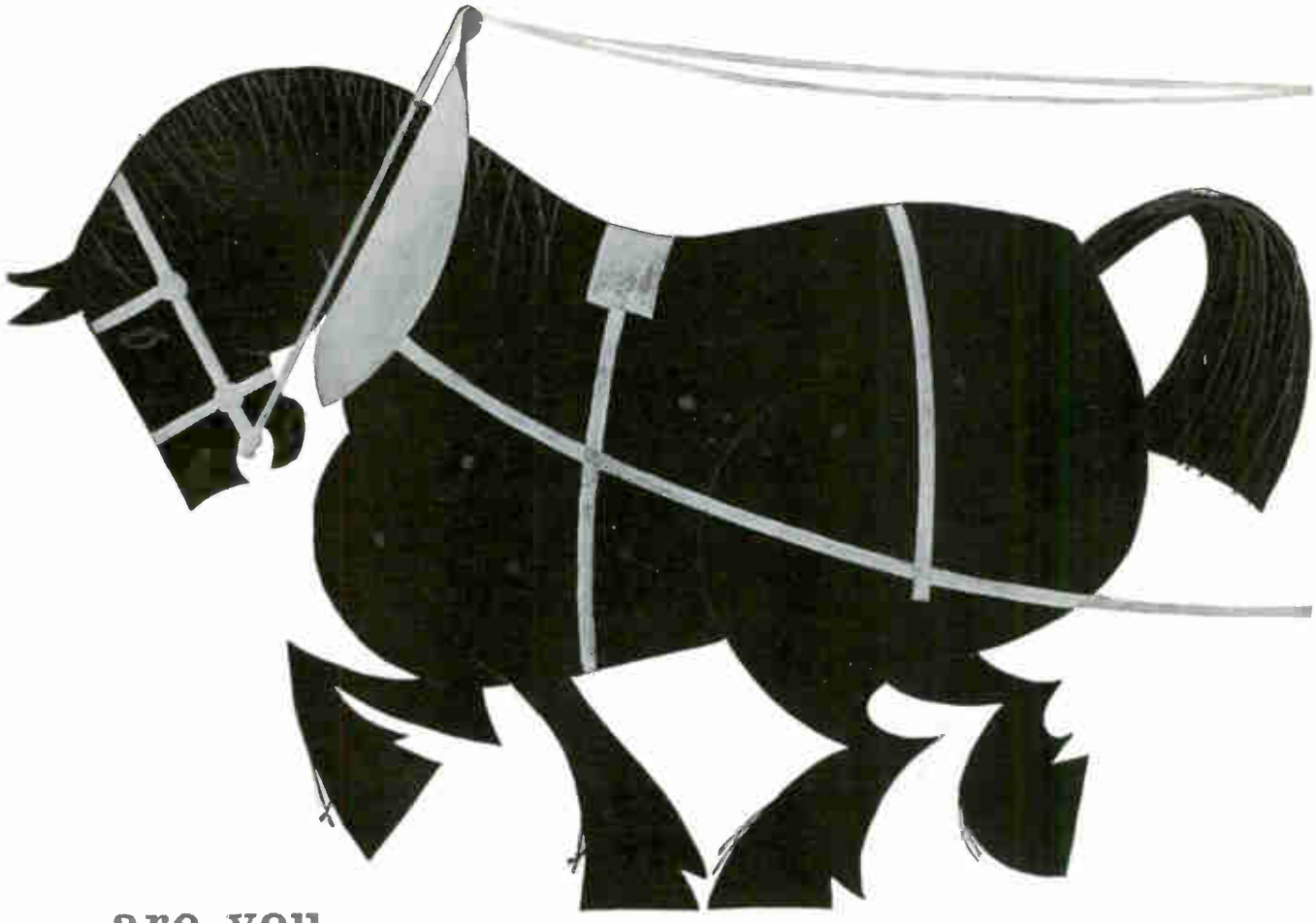
Japan's Instrument Firms Plan Overseas Servicing

TOKYO—Japan's Industrial Measuring Instrument Industry announces plans to establish overseas service stations for its member firms in the near future. This is to facilitate export of the Japanese industrial measuring machines but no details have been worked out.

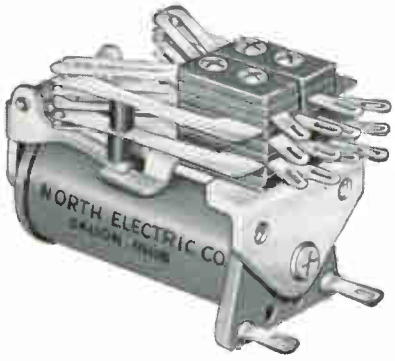
No site was mentioned for the first service point. "It would be cheaper to tie-up with some U.S. firms to service our machines and instruments," said Tetsuo Horiguchi, association manager.

Mobile Teletypewriter Used By Marines

Designed for military service, teletypewriter by Mite Corp. uses solid state line sensing, operates to 100 words a minute



are you using North Electric's **Workhorse** "E" relay?



Expanded production facilities and increased efficiency in manufacturing methods have enabled North Electric to step up production of "E" relays to provide prompt delivery (at a new low cost, too) to an ever-growing list of steady customers.

If you need a relay that incorporates the inherent proven dependability of a telephone-type relay with minimal spatial requirements, this "little workhorse" from North can be your answer!

GENERAL CHARACTERISTICS:

Light Weight (2½ ozs.)
Compact (Length 2¼"; Width 1⅛"; Height 1¾" max. with 10 springs in either pile-up)
Long Life (over 100 million operations)

SPECIFICATIONS:

Coil Voltages: Up to 250V DC
Contacts: Independent action twin contact springs
Contact Materials: Palladium, Gold
Forms: A to C. Solder or taper tap terminals
Speed: 3 ms. minimum
Residual: Lock Screw (adjustable)—Fixed (nylon flap type)
Time Delay: Available for both operate and release
Coil: Single or Double wound
Mountings: 2 #6-32 Screws on ¾" spacing
Accessories: Dust Cover and Hold Down Bracket With 8, 11 and 20-pin plugs

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

146 S. Market St. *Galion, Ohio*

MEETINGS AHEAD

June 26-27: Vacuum Metallurgy Conf., American Vacuum Society; New York Univ. Heights Campus, New York City.

June 26-July 1: International Measurement Conf. and Instrument Show, IMEKO, IMIS, Engineering Societies Bldg., Budapest.

June 26-28: Military Electronics, National Convention, PGME of IRE; Shoreham Hotel, Wash., D.C.

June 26-30: Aero-Space Technical Conf., Concepts & Design, AIEE; Ben Franklin Hotel, Philadelphia.

June 28-30: Joint Automatic Control Conf., AICHE, AIEE, ASME, IRE, ISA; Univ. of Colorado, Boulder, Colo.

July 5-9: Radio Techniques and Space Research, British IRE; Univ. of Oxford, England.

July 16-21: Conf. on Medical Electronics & Conf. on Elec. Tech. in Med. & Bio., IFME, JECMB, PGBME of IRE; Waldorf-Astoria Hotel, New York City.

July 24-26: Air Traffic Control Symposium, Electronic Maintenance Engineering Assoc., (EMEA); Mayflower Hotel, Washington, D.C.

Aug. 13-18: Magnetohydrodynamics, Seminar, Penn State Univ., University Park Pa.

Aug. 16-18: Electronic Circuit Packaging Symposium; Univ. of Colorado, Boulder, Colo.

Aug. 22-25: WESCON, L.A. & S.F. Sections of IRE, WEMA; Cow Palace, San Francisco.

Aug. 23-Sept. 2: National Radio & TV Exhibition, 1961 British Radio Show; Earls Court, London.

Sept. 11-15: Instrument-Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE, Int. Amphitheatre, Chicago.

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

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Sierra offers you now

Model 160 50-ohm Coaxial Loads

Now including Models operating to 11 KMC, Sierra 160 Series low VSWR terminations may be used when stable 50 ohm loads are required. Featuring rugged design, high stability at full rated power, the loads have a typical VSWR of 1.2. All models are air-cooled and complete shielding insures personnel safety. Models with power capacities of 1, 5, and 20 watts are available with N, C and BNC connectors. 100 and 500 watt models are provided with Type N connectors. $25.00 to $200.00.

Model 185A Average-Reading Termination Wattmeters

Sierra 185A series are particularly useful in terminating rf coaxial transmission systems, measuring average powers between 20 and 1,000 MC, and as dummy loads for testing and adjusting CW and FM transmitters and oscillators. Two models with maximum power dissipation of 100 and 500 watts, and power ranges of 0 to 30/100 and 0 to 150/500 watts, respectively. Accuracy is ± 5% and VSWR is 1.2. Female Type N connectors. 185A-100FN, $260.00; 185A-500 FN, $375.00.

Model 164A Average Power Monitors

Sierra 164A Series Bi-Directional Power Monitors are now available with plug-ins down to 2 MC. Four plug-ins provide full scale ranges of 1, 5, 10 and 50 watts through frequencies 25 to 1000 MC. Two medium-power units provide full scale ranges 10, 50, 100 and 500 watts, 25 to 1000 MC. Three high-power units provide full scale ranges of 50, 100, 500, 1000 watts, 2 through 470 MC. Model 164 is now available with Type N, C, HN, UHF and LC connectors. Model 164, $115.00; plug-ins, $75.00 to $170.00.

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

Model 194A-A Bi-Directional Peak Power Monitor

Covering the range 200 to 1,215 MC, Sierra 194A-A Peak Power Monitor offers two important, time-saving features—peak power is read directly without computation and a reversible directional coupler permits incident or reflected power readings simply by turning one knob. Peak powers to 30 Kw are covered in 4 ranges. Measurement accuracy is ± 10% full scale at pulse widths down to 0.1 μsec or repetition rates as low as 10 pps. Minimum duty cycle 0.04% for specified accuracy. $780.

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For complete details, see your Sierra Representative or write direct.

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6561R

Familiar product . . . new use

In the hands of experts, a well-known product has found a new use, brought about by today's fast moving technology. A spacer with electrical insulating and special mechanical properties was required for this stud-mounted power transistor. CDF solved the problem with paper phenolic rolled tubing, a long-established grade. Fabrication of the spacer is accurate and low cost on automatic screw machines.

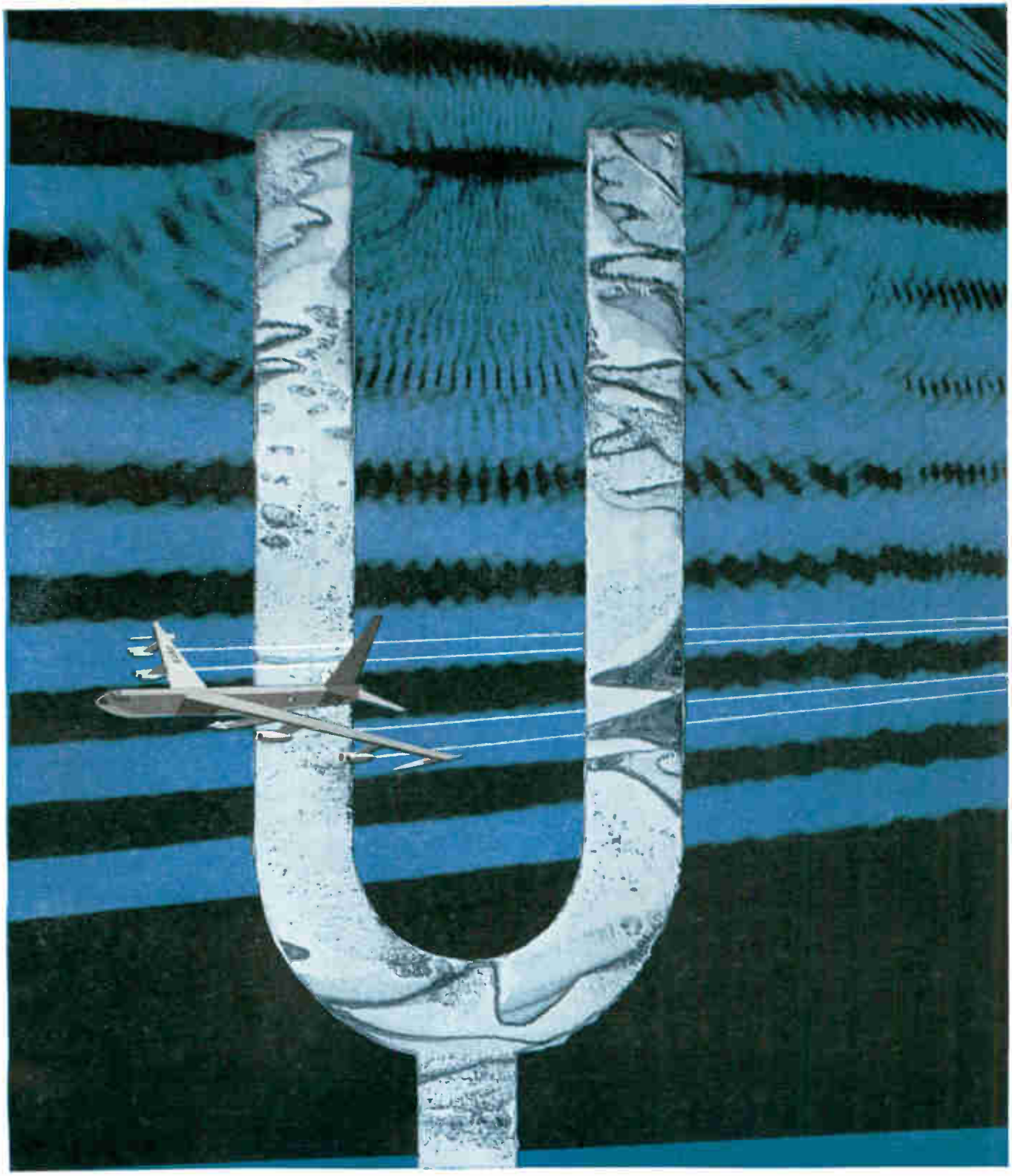
Result: Reliability is assured through use of a time-tested and proven material, while costs are kept to the minimum.

A few facts on the tubing: (1" x 1⅛")

Dielectric strength, perp., vpm	400
Min. density	1.12
Water absorption, %	3.0
Axial compression, psi	13,000

CDF® **CONTINENTAL-DIAMOND FIBRE**

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE Budd COMPANY



YOU'RE STILL TUNED IN, HERR PROFESSOR DOPPLER!

Back in 1930, your principle helped provide the first step in the development of radar. Since that time, radar has grown up . . . always depending on the Doppler shift to measure the velocity of a moving object. Now, we're about to put your principle to work again; this time as an integral part of the Bombing Navigation System for the B-52 weapons system.

If you would like to help us apply yesterday's principles, like Doppler's, to important projects like B-52 navigation, and if you have a BS, MS or PhD in EE, ME, Physics or Math, please contact Mr. G. F. Raasch, Director of Scientific and Professional Employment, Dept. C, 7929 S. Howell, Milwaukee 1, Wisconsin.

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

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MILWAUKEE • LOS ANGELES • BOSTON

General Electric 2N1217 NPN's are characterized for starvation circuits under 2ma

Type No.	Maximum Ratings P_T (mw) @ 25°C	BV_{CE} BV_{CB}	Ic ma	Electrical Parameters (25°C) h_{FE} MIN	@ Ic ma	$f_{\alpha mc}$ MIN	$G_e$db MIN	I_{CO}* (μa) MAX	@ V_{CB}	Application
2N78	75	15	20	45	1	5	29	3	15	RF Amplifier
2N78A	75	20	20	45	1	5	29	3	15	RF Amplifier
2N78A (cert)	65	20	20	45	1	5	29	3	15	RF Amplifier
USA2N78A (per Mil-S-19500/90)	65	20	20	45	1	5	29	3	15	RF Amplifier
2N167	75	30	75	17	8	5	—	1.5	15	High Reliability High Speed Computer Switch
2N167A	75	30	75	17	8	5	—	1.5	15	
USAF 2N167A (per MIL-S-19500/11B)	70	30	75	17	8	5	—	1.5	15	
2N169A	75	25	20	34	1	—	27	5	15	General Purpose Low Noise Amplifier
2N1198	75	25	75	17	8	5	—	1.5	15	Computer Switch
2N1217	75	20	25	40	.5 — 2	6	—	1.5	15	Starvation Switch
2N1510	75	75	20	8	1		—	5	75	Neon Indicator Driver
2N1694	75	20	25	17	1	3	—	1.5	15	Decade Counter Switch

*Typical Ico at 70°C is less than 10 μa

General Electric 2N1217 characterizes the minimum and maximum parameters required for reliable starvation circuits under 2 ma, featuring extremely low collector cutoff current, high D-C beta down to 100 μamp collector current, and low collector capacity. In addition to the 2N1217, General Electric types 2N167A, 2N169A, and 2N1694 also offer the same unique combination of advantages when operated at low current levels, including:

- **Reduced equipment size**
- **Reduced air conditioning requirements**
- **Reduced power supply requirements**
- **Improved reliability**
- **4 to 1 improvements in switching speeds over alloy transistors**

For complete information, including data that shows less than 5% shift in voltage, leakage current, and h_{FE} over 5,000 hours of life and extremely low failure rates on life tests, call your Semiconductor Products District Sales Manager, or write Semiconductor Products Department, Section 25F99, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N. Y. 17, N. Y.

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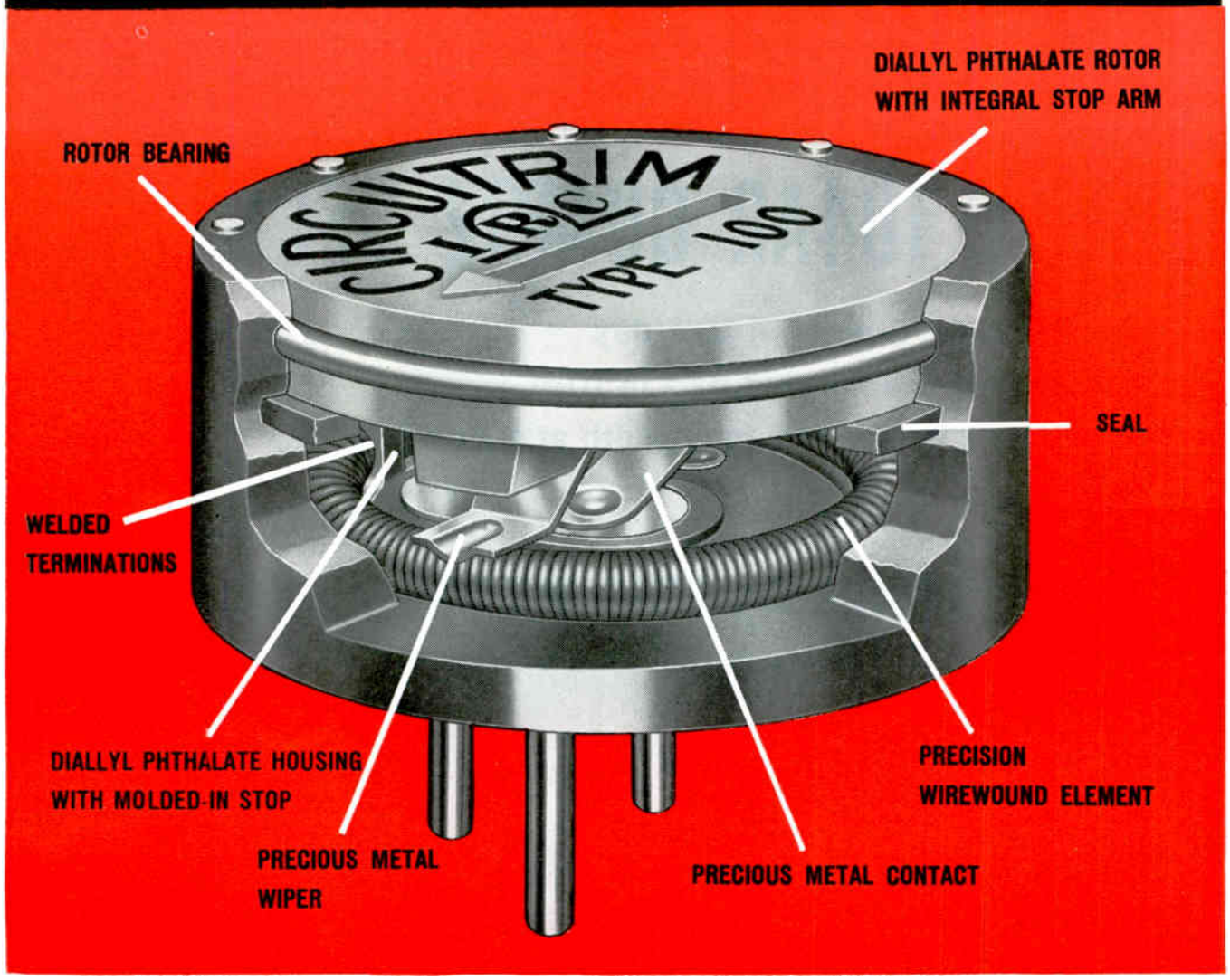

EXPOSED...a new simplified trimmer design increased reliability...added economy

The new IRC ½" round Circuitrim trimmer with its unique mechanical design (depicted above) simplifies the complex mechanical linkage used for adjustment in most trimmers making it more reliable and less costly. This round trimmer design employs the same fine electrical assembly found in IRC's popular square trimmer. Available in twelve standard ranges from 10 ohms to 50K ohms, 1 watt. Higher power rating available.

Set it and forget it is the paramount feature of IRC's new square trimmer, made possible by an exclusive self-locking, antibacklash spiroid drive gear. Square Circuitrim has superior moisture, shock and vibration characteristics, and is interchangeable with earlier designs. Teflon leads and seals standard. Printed circuit terminals available. 10 ohms to 50K ohms, 1 watt. Write for technical bulletins. International Resistance Company, 401 N. Broad St., Philadelphia 8, Pa.

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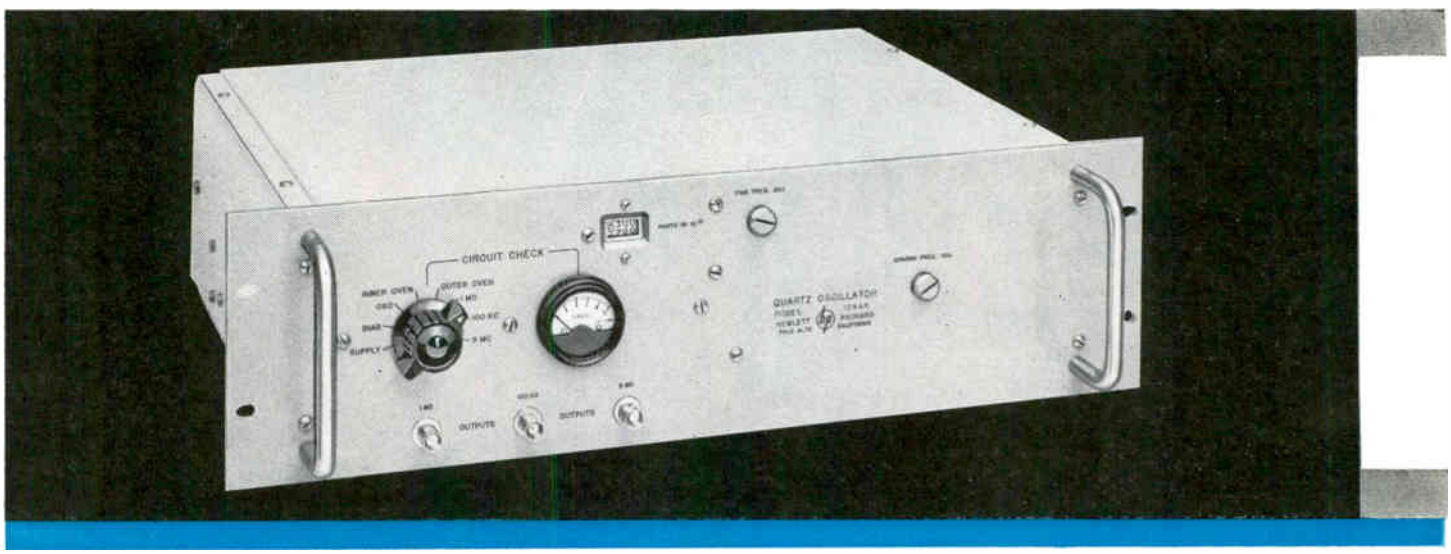
Long term stability: 5 parts in 10^{10}/day

Typical short term stability*: 1 part in 10^{10}

Spectral purity: 2 cps typical bandwidth at X-Band

*averaged over one second intervals and under reasonably constant environmental conditions.



hp 724BR/725AR Standby Power Supplies

These standby power supplies are completely automatic, assure continued operation of frequency and time standard systems in the event of ac line power failure. Standby batteries floating across supply outputs, instantly assume load, without switching, in case of ac failure. Battery recharged automatically after ac line power is restored. hp 724BR battery operates 103/104AR, 113BR up to 48 hours. hp 725AR battery operates 103/104AR, 113BR at least 6 hours. hp 724BR, 75 lbs., $850.; hp 725AR, 20 lbs., $625.

Precision instruments for "Building Block" frequency/time standard systems allow comparison with HF, VLF standard broadcasts.

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

The accuracy, stability and spectral purity you need for communication, navigation, missile guidance, satellite tracking and other advanced frequency/time standard applications are yours now with the new hp 104AR Quartz Oscillator.

Model 104AR provides a 5 MC output of extreme spectral purity that retains the stability of the 1 MC oscillator. Spectra only a few cycles wide may be obtained in the X-Band region by multiplication of the 5 MC output. Model 104AR also provides 1 MC and 100 KC sinusoidal output signals, plus a separate 100 KC output for driving hp 113BR Frequency Divider and Clock in frequency and time comparison measurements and time signal generation. The 113BR, which permits greater absolute accuracy from frequency or time standards and is suitable for HF or VLF comparisons, is described below.

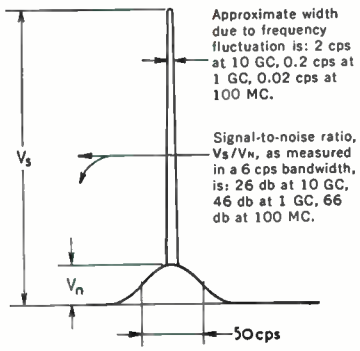
Continuous operation of hp 104AR and hp 113BR is assured with hp 724BR/725AR Standby Power Supplies (also described below). Models 724BR/725AR provide power for the oscillator and frequency divider, and incorporate batteries to insure operation of the system in case of ac power failure. These instruments, plus a comparison device and a receiver, provide a compact, lightweight, rugged, stable and accurate primary frequency and time standard system.

The new hp 104AR Quartz Oscillator, which is completely transistorized, employs a proportionally-controlled double oven which houses the crystal and all critical frequency-determining elements. Crystal dissipation level is kept constant at less than 1/4 μw by AGC action. Frequency changes due to variations in supply voltage and load impedance are virtually eliminated as a result of internal voltage regulation and excellent buffering.

SPECIFICATIONS, hp 104AR

Overall Stability:	Long term: 5 parts in 10^{10}/day. Short term: Better than 5 parts in 10^{10} averaged over 1 sec. intervals. (Includes effects of temperature, supply voltage and load impedance.)
Output Frequencies:	5 MC, 1 MC, 100 KC, 1 v rms into 50 ohms, 100 KC for driving hp 113AR/BR.
Harmonic Distortion:	At least 40 db below rated output.
Non-harmonically Related Output:	At least 80 below rated output.
Output Terminals:	5 MC, 1 MC, 100 KC, front and rear BNC connectors.
Frequency Adjustments:	Coarse: Screwdriver adjustment with range of approx 1 part in 10^6. Fine: Front panel screwdriver control with range of approx. 600 parts in 10^{10}. Digital indicator calibrated directly in parts in 10^{10}.
Monitor Meter:	Ruggedized front-panel meter and associated selector switch monitors the SUPPLY voltage, BIAS, OSC current, INNER OVEN current, OUTER OVEN current, 1 MC output, 100 KC output.
Temperature Range:	0 to 50° C.
Size:	19" x 5¼" x 14" deep behind panel. Approx. 20 lbs.
Price:	hp 104AR, $3,250.00

Typical Spectral Purity, hp 104



hp 113BR Frequency Divider and Clock

This improved hp instrument uses a directly calibrated precision resolver as a time reference control, offers unique jitter-free optical gating system. Clock is fail-safe, incorporates regenerative non-self-starting dividers insuring neither gain nor loss of time with respect to driving oscillator. Time reference is continuously adjustable, directly calibrated in millisecond and 10 microsecond increments. Manual-start clock, 24 hour dial, minute hand adjustable in 1 minute steps, second hand continuously adjustable. hp 113BR, $2,750.

hp 103AR Quartz Oscillator

Offers excellent spectral purity, and same long-term and short-term outputs as Model 104AR. Outputs same as 104AR except does not include 5 MC output. Completely transistorized, rugged, withstands severe environmental conditions. Otherwise electrically similar to 104AR. hp 103AR, $2,500.

hp 114BR Time Comparator

An auxiliary unit used in conjunction with the hp 113BR, the hp 114BR allows time comparison without affecting clock outputs, provides additional speed and flexibility in making time comparisons between stable oscillators and standard time signal transmission. Range, time intervals 0-999 milliseconds between ticks from hp 113BR and standard time signal station, can be used with VLF or HF time signals. hp 114BR, $1,200.

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electronics
June 23, 1961

MEDICAL ELECTRONICS Part IV:

Prosthetics—Hearing Aids and Blind Guidance Devices

Here are some of the electronic aids helping overcome the tremendous handicap imposed on persons who are wholly or partially deprived of sight and hearing

By WILLIAM E. BUSHOR,
Associate Editor

THE BLIND and the deaf have a stake in that part of medical electronics dealing with prosthetics—substitutes for missing or nonfunctioning parts of the human body. These victims of disease and injury may one day reap a bountiful harvest from the seeds of experiments sown today, but few sensory aids have been developed to the point of practical usefulness.

Hearing aids represent the most startling departure from this general trend, for they are technically practical, economically feasible and commercially available on a competitive basis. Blind guidance devices, described here, and readers for the blind, hear-by-touch aids and artificial eyes and ears, to be described in Part V, are still in the crawling stage.

Hearing Aids—Although there are more than 12 million adults and 3 million children in the U. S. with a hearing problem, few of them are actually deaf—most have hearing losses of varying degrees. Of these 15 million people, 2½ million now use aids and another 6 million could effectively do so.[1]

Personal vanity seems to be the significant factor determining if a hearing aid is purchased at all and also in selecting the type of aid used. This is such an overriding psychological prejudice that many persons prefer inconspicuous aids with lower performance ratings to more visible types which better compensate for the hearing loss.

To effectively conceal the fact that a hearing aid is being worn, manufacturers have developed tiny, cordless units that are placed at ear level. Some mount into eyeglass frames, others hook behind the ear and a few are actually placed completely within the entranceway to the ear.

Manufacturers agree that the trend is and will continue to be toward developing smaller and less obvious devices. They also are unanimous in stating that further miniaturization is limited by the size of the batteries and of the input-output transducers, not the electronic circuits.

Innovation of the transistor, which eliminated the vacuum tube and B battery, has helped reduce the bulky, heavy instruments of 20 years ago to units, smaller than a thimble, that weigh less than one third ounce. Also, the expense of operating hearing aids has been

Less than 20 years ago hard of hearing children wore heavy, bulky vacuum-tube hearing aids (top) with a separate battery case carried at hip. Today, a new miniature ear-level aid (inset) sold by Zenith Radio Corp. fits behind the ear with the only visible evidence being a tiny tube entering the ear canal (bottom)

cut by about 80 percent, primarily through reducing the current drain responsible for short battery life.

To understand how hearing aids compensate for hearing inadequacies, it is necessary to know how the human ear functions. Because the present theory of hearing is extremely complex, only the general principle will be outlined.

Figure 1 shows the anatomy of the human ear. It is made up of three parts—the outer, middle and inner ears.

Sound waves picked up by the outer ear (auricle) pass through the external canal and cause the eardrum (tympanic membrane) to vibrate. These vibrations are carried along the middle ear (tympanum) by the ossicles (an elastic bridge of three connected bones—the smallest in the body). The ear drum moves the hammer, which activates the anvil whose motion pushes the stirrup attached to the oval window (a movable membrane lying between the middle and inner ears). Thus, all vibrations of the eardrum are duplicated by the oval window.

Vibration of the oval window sets into motion the fluid that fills the inner ear. This oscillating fluid passes through the cochlea (a bony structure resembling a snail shell with 2½ spirals), exiting through two oval ports. When the oscillations reach the round window, volume displacement takes place equal to that produced at the oval window. This streaming of the fluid sets up a pressure difference across the cochlea which deforms the sensory cells on its walls. These cells tickle 25,000 nerve endings, which respond something like the strings of a harp. The eighth, or hearing nerve, telegraphs the message to the brain where it is received as a sound impression.[a]

Defects in this hearing apparatus are of two major types. One is a perceptive impairment (also called nerve deafness), where the transmitting apparatus of the ear is working properly, but some or all of the nerve endings in the inner ear are not functioning. The other type is conductive deafness, where the conductive apparatus of the ear breaks down. Combination forms of perceptive and conductive impairment also exist.

Perceptive loss requires a hearing aid which will deliver corrected sounds by air conduction to the nerve endings in the inner ear. An instrument is used which sends all sounds through the ear in the normal fashion but increases the intensity of those sounds where the cochlea is deficient. If nerve deafness seems to be present in all frequencies of sound, the entire level is stepped up. This type of aid is worn wholly or partially in the ear.

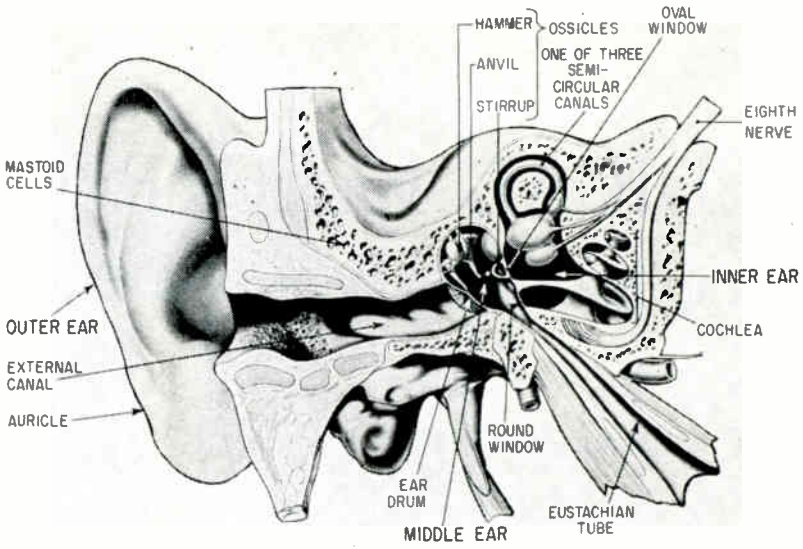


FIG. 1—Sectional diagram of the human ear as conceived by Sonotone. Because of difficulties in examining the ear anatomically, its physical structure was misrepresented for centuries

For conductive loss, a bone-conduction hearing aid is used. This aid is worn behind the ear—nothing is worn in the ear. Sound is transmitted directly to the cochlea through the mastoid bone (Fig. 1), eliminating the function of the outer and middle ears. Sound vibrations in the air are converted into mechanical vibrations which travel through the bony structure of the head to fluid in the inner ear.

Since no two hearing losses are exactly alike, hearing tests to determine the type and degree of hearing impairment are made by most hearing-aid manufacturers. The acuity and range of hearing is measured with either a pure-tone or speech type audiometer. Because one or the other ear of most people hears better, the test is usually made on both ears—first with an air-conduction and then with a bone-conduction receiver. The pure tone audiometer produces a series of tones which vary in pitch and intensity. Points at which the listener can no longer hear separate sounds are plotted on an audiogram—or hearing chart—which gives a clear picture of hearing loss. People with normal hearing can detect about 325 differences of loudness level in a single tone and 1,500 differences in pitch between tones. Often the tone test is supplemented with a word test in which the definition of hearing is measured. Through these techniques it can be determined what type of hearing loss exists, how much hearing ability has been lost and how much remains, where the loss is located and what compensation the hearing aid should provide.

One technical development which has encouraged many hard-of-hearing persons to use hearing aids hinges on the two-eared or binaural approach to hearing-aid construction. Until the advent of extreme miniaturization, the physical impracticality of using what effectively amounts to two hearing aids was a deterrent. Another problem which remains, however, is that of cost; the binaural aid retails at slightly less than twice the monaural price. Some companies report that customers who intended buying monaural aids almost invariably selected the binaural version after using a switchable monaural/binaural demonstration aid in a home environment.

Binaural aids provide many advantages over the monaural type.

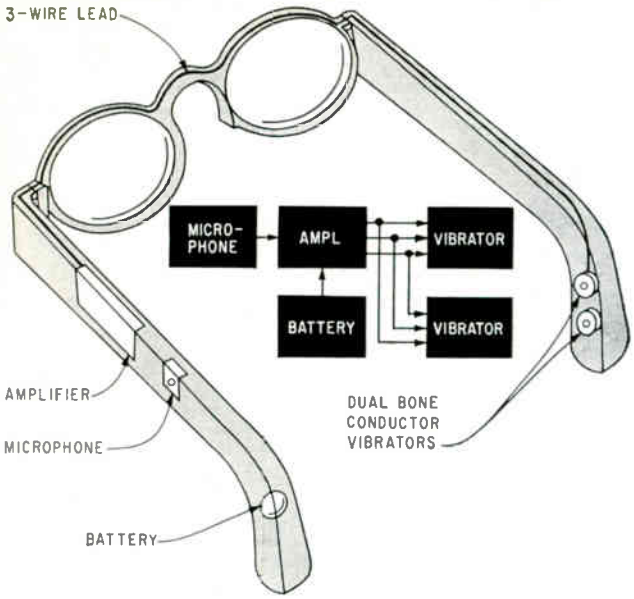
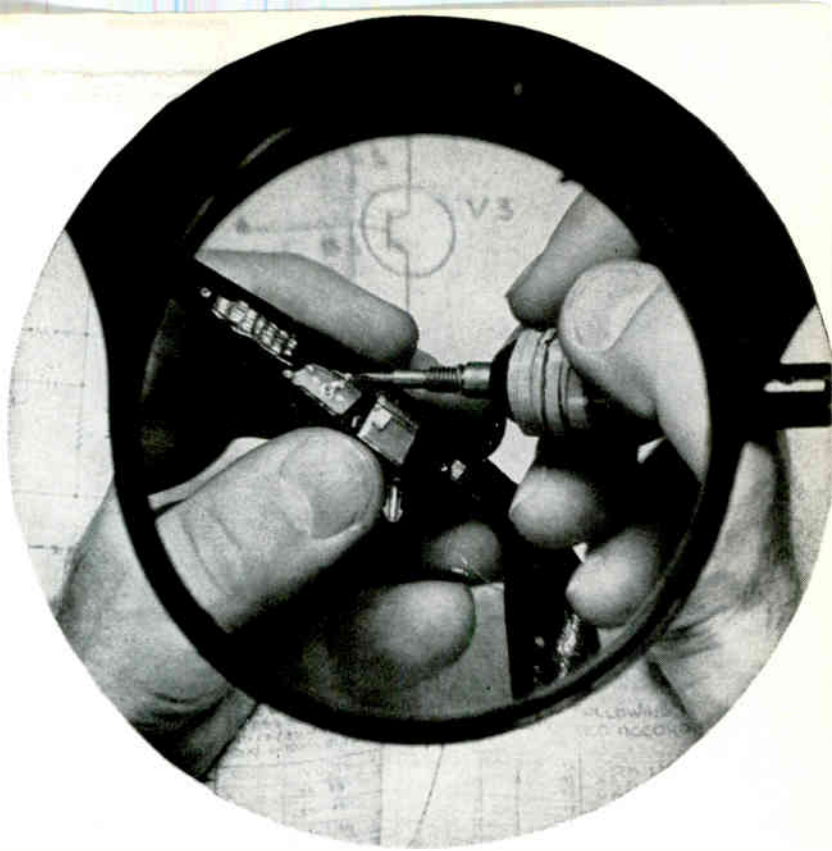


FIG. 2—Acousticon's unusual bone conduction eyeglass aid uses two output transducers as far removed by the receiver as possible to get maximum power transfer without feedback



Magnifier assists production worker in assembling miniature components used in Acousticon's eyeglass hearing aid

Most important, they permit the user to understand speech in the presence of competing noise by providing discriminative selection (the ability to suppress undesired sound). Although acuity—the ability to hear weak sounds—is not improved, it takes less effort to hear with two ears than with one because the brain can suppress unfavorable room vibrations when hearing is done binaurally. Thus, common sounds such as wheels rolling over the road can be identified easier. Also, sound quality is improved, and direction and distance to a sound source can be determined.[5, 6]

Acoustic feedback, considered a problem with binaural aids, can be overcome by proper design. A help is that a person wearing a binaural aid tends to use considerably less gain in each channel than he does with a monaural aid. The binaural arrangement does not work well with bone conduction techniques because there is only a 3-db loss from one side of the head to the other and the signals are confused. By carefully controlling the phasing between signals applied to the left and right ears, a workable binaural bone conduction aid may eventually prove feasible.

Most hearing aids manufactured today have separate on-off and volume control switches to eliminate the necessity of setting the volume control each time the aid is turned on, as would have to be done with a combination switch. Many aids have thermostatically controlled circuits which automatically balance their performance when the wearer moves to a different ambient temperature. Automatic volume control circuits are usually included to subdue distracting sounds and protect the auditory nerve from sudden shocking noises.

Ear level aids (in-the-ear, behind-the-ear, barrette and eyeglass) usually do not have enough gain or power output to compensate for all hearing losses, thus they are recommended only for slight or moderate hearing losses. The majority of these aids are used only for perceptive loss, that is, they utilize air conduction.

In-the-ear aids have the microphone, electronic circuits, earphone, and battery combined into an earplug-sized unit. Dahlberg's Miracle-Ear III, which can also be worn behind the ear, contains two transistors and weighs ¼ ounce. This aid does not require an ear mold; sound is introduced directly into the wearers ear canal. Otarion's ear canal aid weighs a bit more, ¾ ounce, but fits into the ear so that it does not project beyond the tragus—the small piece of cartilege at the entrance of the ear canal. Still another aid, Beltone's recently introduced Utopian, has a volume of ¼ cubic inch and weighs ⅓ ounce. This unit provides compensation for mild hearing losses for those who only occasionally use an aid.

Behind-the-ear aids, which generally hook over the top of the outer ear, have a clear plastic tube that connects the earphone (usually built into the aid) to the ear mold. The problem of electrical, acoustical and mechanical feedback is solved by using shielding, by isolating vibration or by placing the input and output transducers in mutually perpendicular planes.

Otarion's Whisperwate-X, weighing in at ¼ ounce, uses four transistors to get a power gain reported to be between 85 and 90 db. Accousticon's $\frac{3}{10}$-ounce Privat-Ear also uses four transistors but gets a maximum gain of 43 db. Beltone's three-transistor Jubilee gives a maximum acoustic gain of 55 db. Dahlberg's ½-ounce Mark III also uses three transistors, but gives a maximum acoustic gain of 43 db. Unlike the others, this unit has provision for inserting six different tone tips at the aid side of the sound tube to give varied frequency response to suit individual requirements of each person's ear. Telex' Model 37 has a maximum

Different approaches to design of guidance devices for the blind

Type of Radiation	Firm or Investigator	Type of System	Principle of Operation
SOUND **Advantages** Comparatively simple Uses natural faculties of user to maximum Is highly versatile source of travel information **Disadvantages** Cannot be used in noisy or conjested areas Audible output attracts attention No warnings are given of step-downs Because user listens directly to echo (except in pan-audio system), hearing channel—needed for other purposes—is tied up	R. L. Beurle Experimental and Research Dept. of St. Dunstan's, London, Eng.[7]	Audible Clicker (portable)	Sound source, a rochelle salt bimorph pair, emits clicks when actuated by transients produced by a capacitor discharge through a cold-cathode triode. Source is placed at focus of parabolic reflector to form beam of high-pitched audible sound. Time delay in reception of pulses indicates distance; longer delays correspond to greater distances, shorter delays to shorter distances. Most useful in strange surroundings. Helps teach blind significance of echoes.
	V. Twersky New York U.[8]	Spring Vibrator (portable)	Consists of paraboloidal horn with dented flat steel spring vibrator mounted in focal plane. Downward pressure on protruding trigger vibrates spring. Distinct echoes can be obtained from isolated buildings and trees over fifty feet away. Device is too loud. Effective only if obstacles are more than twenty feet away.
		Sonic Whistle (portable)	Consists of paraboloidal horn with a whistle transducer mounted in back of focus. Whistle is attached to rubber bulb that is squeezed to give sound, which resembles high-pitched bird-like squeeks. Variety of sounds can be produced by altering method of manipulating bulb. Definite perceptions for distances up to 10 to 15 ft were obtained. Can detect doorways, windows and large pieces of furniture. Produces good localization clues.
	C. M. Witcher and L. Washington, Research Lab for Electronics, MIT[9]	Audible Clicker (portable)	Crystal sound cell is located in focal plane of paraboloidal horn. Capacitor charge and discharge characteristics are used to set up damped oscillations. Deflector diverts sound to one side or the other of main beam. Series of pulses is produced each of which consist of a damped oscillation at about 9 Kc. Pulse repetition frequency is adjustable between 16 and 30 pulses a sec. Provides satisfactory detection of large obstacles at distances of 25 to 30 feet when ambient noise is low.
		Automatic Scanning Audible Clicker (portable)	Two paraboloidal horns and crystal sound cell transducers are used. Horns are mounted so sound is projected vertically downward until it strikes an elliptical reflector and is deflected horizontally out of the device. Small motor drives elliptical reflector through an angular oscillation so sound emerges with a sinusoidal right-and-left scanning motion. Pulses at 10 Kc are projected over 60-degree angle at rate of 0.7 to 1 scans a sec. Gives better information than manual scanning method.
	V. Twerksy CCNY[10]	Sound Flashlight (portable)	User moves device with scanning motion. Beam 12 to 30 deg wide is generated by single tube oscillator operating between 8 and 15 Kc. Transmitter transducer, an ordinary headphone, is mounted at focal point of paraboloidal reflector. Obstacles, upward stairs and open doorways can be detected up to 30 ft away.
	D. Griffin Cornell U.	Snapper (portable)	Metallic snapper is mounted in paraboloidal reflector.
	Valradio, Ltd. Feltham, Eng.	Sound Flashlight (portable)	Uses high-frequency loudspeaker and horn. Emits narrow beam of high-pitched sound which rebounds when it strikes an object enabling user to judge the distance and location of obstacle through change of pitch. Can detect obstacles up to 20 ft away. Device is still in prototype stage.
	(Proposed Technique)	Pan-audio System (portable)	Enhances sounds normally generated by user or produced ambiently. A hearing aid is worn for each ear. Most sounds remain the same as before except that heel clicks and similar steep wavefront noises are increased in intensity for a few millisec. It has been difficult to secure useful directional information.
ULTRASOUND **Advantages** Comparatively unaffected by rain, fog and sunlight Can detect step-ups Speed of wave transmission permits use of radar-like principles	General Dynamics/ Electronics (formerly Stromberg Carlson)[11]	Simple Pluse System (laboratory model)	A 32-Kc oscillator generates pair of pulses at repetition rate adjustable between 5 and 50 pulses a sec. One pulse is fed to magnetostructive radiator, other to receiver portion of system. Echo pulse is picked up by magnetostrictive microphone and fed to tuned receiver. Then, echo pulse and pulse sent directly from oscillator are combined in detector; the distance to obstacle is determined by measuring elapsed time between two pulses on oscilloscope.
		Echo-Pulse Method (portable)	A 30-Kc oscillator generates pulse when triggeree by first echo of previous pulse. Range indication given by change in pulse repetition rate (5 to 30 pulses a sec); fast rates indicating nearby objects, slow rates distant objects. Maximum range is 20 feet. Magnetostrictive radiator and microphone used; stimulus is tactile. Frequency range is insufficient for tactile presentation. Also, echo fluctuation generates unevenly spaced pulses making repetition rate hard to determine.
		F-M System (laboratory model)	Oscillator produces ultrasonic signal whose frequency is varied cyclically as a function of time. Difference between echo frequency and frequency of ultrasonic oscillator at time echo returns is function of distance to obstacle. This difference frequeney is made audible by mixing oscillator signal and echo in nonlinear circuit; high-pitched tone indicates nearby obstacle, low more distant obstacle. Magnetrostrictive radiator and microphone are used.
		Pulsed F-M System (portable)	A 30-Kc oscillator produces signal whose frequency varies as function of sawtooth waveform. Received echo is 50-ms pulse of changing frequency. Echo and original oscillator signal are combined in mixer; resulting audible beat note is fed into headset. User listens to various frequency components of signal; heard first are low frequencies indicating nearby obstacles, then higher frequencies indicating distant objects. Another model uses 65-Kc oscillator permitting use of smaller megnetrostrictive transducers; bone conduction receiver takes place of headphone.
Disadvantages At best is only good for go no-go obstacle detection Efficiency is reduced by specularity; air turbulence and Doppler effects Cannot detect stepdowns	Hoover Co. Research Lab	Pulse Modulation System (portable)	Low frequency ultrasound is generated by mechanically struck bar. Received energy is amplified and mixed with output of local oscillator; resulting audio beat tone is amplified and fed into earphones. Auditory signal consists of series of pulses. By changing position of lever on handle, signal is obtained—angle of lever, indicated by pin on handle, is proportional to range.
	Brush Development Co.	Sine Wave Modulation System (laboratory model)	Signal produced by crystal-type generator is modulated with sine wave; frequency difference between transmitted and received signals is function of transit time. User hears auditory signal consisting of warbled tone; high tones indicate distant obstacle, low nearby obstacle.
		Constant-Rate-of-Modulation System (laboratory model)	Same as sine-wave modulation system except signal is modulated with sawtooth wave to give steady rather than warbled audio pulses. Sawtooth wave generator frequency modulates an ultrasonic generator whose output is amplified and applied to a crystal transducer. Received signal is mixed with portion of outgoing signal producing a-f beat which is amplified and applied to earphones.

gain of 38 db and weighs only ⅓ ounce. Another ⅓-ounce unit, Zenith's Signet, can be modified to attenuate high or low frequencies with a maximum acoustic gain of 48 ±3 db.

Zenith's barrette aid, weighing an ounce, has a unique top-mounted microphone that reduces noise from clothing rustle and can be utilized for persons needing a bone conduction unit. Two-position tone control gives user choice of standard or high-frequency emphasis; acoustical gain is 60 db.

Eyeglass aids generally have the microphone, electronic circuits, earphone and battery mounted in one temple bar, as the arms on eyeglasses are called. Most common is the air conduction type, which uses a clear plastic tube making the connection to the ear; some bone conduction aids are also offered. Since using the telephone presents a problem with these aids, most have a special telephone pick-up and switch. Sonotone's Sovereign 430, a four-transistor device, permits normal use of the phone by

Type of Radiation	Firm or Investigator	Type of System	Principle of Operation
Parabolic reflector required to obtain narrow enough beam to avoid specularity must be 20 to 30 times wavelength, thus is impractical for portable gear	J. W. Richardt O. A. Schann	Cane System (portable)	Cane with built-in ultrasonic device that is energized by leaning on cane. U. S. Patent No. 2496639, February 7; 1950.
	R. L. Beurle Experimental and Research Dept. of St. Dunstan's, London, Eng[7]	Three Narrow-beam Scanning Systems (portable)	These three devices function similarly except with respect to beam width and frequency. Regular ultrasonic pulses are transmitted. Outgoing and echo pulses are heard in earphones at about same intensity. Two clicks are produced in earphone each time pulse is transmitted; time interval between clicks is proportional to range to obstacle. Two of these devices give 10-deg beam; one operates at 150 Kc, the other at 55 Kc. The third device gives 20-deg beam and operates at 17 Kc.
		Wide-beam System (portable)	Device generates wide ultrasonic beam. Echoes are received by two separate receivers whose outputs are passed through a two-path amplifier-detector. Two audio signals produced are fed into binaural earphones: thus system utilizes natural direction finding ability of the two ears.
RADIO FREQUENCY **Advantages** Can detect small changes in level of terrain	Franklin Institute and General Dynamics/Electronics	Electronic Cane (portable)	See text and front cover.
	SITE, Inc.	Electronic Cane (portable)	Similar to system being developed by the Franklin Institute except that recording device in handle tells user to step up or step down.
Disadvantages Detection range is limited to only few inches in front of source	(Proposed Technique)	Antenna Controlled Oscillator (portable)	It has been suggested a ¼-wave antenna be used that will change frequency of high-frequency oscillator when antenna nears an obstacle. Principle is similar to that used in proximity fuses.
VISIBLE LIGHT (Ambient) **Advantages** Does not require user to carry light source	H. E. Kallmann Consulting Engineer[12,13] (portable)	Optar (portable)	When ambient light exceeds one foot-candle, this device will locate and give ranging information on obstacle 100 ft away. Optical system explores space in direction device is pointed at rate of 2½ times a sec. Image received is converted into electrical signal that is amplified by photomultiplier and audio amplifier, and fed to hearing aid earphone. Signal varies from 600 to 2,000 cps; higher frequencies indicate close obstacles, low frequencies distant obstacles. Range is indicated by eight pitch changes representing 20 in. to 20 ft of range. Age compensates for wide ranges of ambient light encountered. Device can be used with flashlight at night.
High sensitivty can be achieved with low power consumption	K. S. Lashley Yerkes Labs of Primate Biology (portable)	Prospecting Type Device (portable)	Device consists of collecting lens, aperture, phototube, d-c amplifier and a-f oscillator and amplifier. When constant light is received, a steady audio signal is produced. If received light decreases, pitch drops sharply then returns to original level; if received light increases, pitch rises sharply then falls to original level.
Disadvantages Regular patterns on obstacles leads to false signals	N. O. Sokal MIT (Master's Thesis)	Pattern-Optical System (laboratory model)	Ambient light reflected from obstacles is automatically scanned by cubical mirror rotating at 10 rpm. Electronic circuits produce audio signal consisting of combinations of frequencies. Because a particular combination of frequencies is generated depending on size and shape of obstacle and its position in the field of view, user can orient himself.
Depends on ambient light, therefore is not useful at night except with auxiliary light source	(Proposed System)	Size and shape Device (portable)	Reflected ambient light strikes phototube whose d-c output voltage is directly proportional to intensity of light received. This signal is fed to a reactance tube that controls output of a beat-frequency oscillator. A constant signal is obtained from the bfo as long as received light remains constant, but changes when intensity changes.
INFRARED, VISIBLE LIGHT AND ULTRA-VIOLET **Advantages** Not specular	C. M. Witcher Research Lab for Electronics MIT	Continuous light reflection system (portable)	This briefcase-mounted device is designed to project light beam on ground forward of user who scans beam back and forth. Source light passes through the lower of two lenses; received light passes through top lens to a photocell. As long as ground has same or uniformly changing elevation, an uninterrupted spot of light is reflected. If the beam passes over a discontinuity in terrain, such as a curb, a momentary interruption of the light spot occurs activating the photocell-controlled stimulus circuit
Can be projected in narrow beam	Haskins Labs	Continuous Tone Device (portable)	Modulated light beam is used as source. Beam reflected from obstacle passes through aperture striking photocell whose output, after amplification and rectification, deflects a meter needle. As the needle moves, a mask attached to it passes in front of the aperture until equilibrium between light intensity on photocell and position of mask is reached. Thus, meter current varies with obstacle distance. A continuous tone of variable frequency is generated by bfo controlled with reactance tube.
Can be used for step-down detection	Evans Signal Labs (Signal Corps and RCA)	Optical Range Finder (portable)	Light beam interrupted 500 times a sec is projected by source. Beam reflected from obstacle is focused by optical system onto a coded disk rotating at 2 rpm that interrupts the reflected beam 4, 8, 16 or 32 times a sec depending on focus point, which is a function of distance. Photocell output, after amplification, activates either a 500 cps vibrator in the handle of the instrument or earphones. Spacing between 500 cps pulse trains inform user of obstacle distance or discontinuity of terrain; short spacing indicates close obstacles, long spacing distant obstacles.
Outline of obstacle can be traced	Haverford College and Biophysical Labs [14,15]	Two and Three Range Systems (portable)	See text.
Disadvantages Performance suffers from saturation due to sunlight	Franklin Institute	Ultraviolet Optical Ranging Device (portable)	This device uses a uv source at wavelengths from 1850 to 2900 A. Distance to an obstacle is determined by automatic triangulation method (see Fig. 3B) using a special type of counter tube. This approach was ultimately abandoned because it was not as immediately realizable as the visible-light Signal Corp device described above. Also, there were considerable technical difficulties with using radiation at uv frequencies.
Rain and fog adversely affect performance			
In general, adequate environmental information and useful range information are difficult to obtain			
Not generally suited to both step-down and obstacle detection by average operator			

mounting the microphone and telephone pickup switch just in front of ear. Beltone's three-transistor Classic corrects for a wide range of hearing losses through a built-in adapter which adjusts the sound spectrum within the band that fits the requirements of the wearer. Acousticon's new model A920 dual transducer bone conduction aid, unlike most others, uses both temple bars, which are connected by a 3-wire cable. As shown in Fig. 2, the output transducers are a whole head-width away from the rest of the aid. This arrangement permits the output transducers to be driven at maximum power without feedback. Use of two output transducers gives less contact pressure on the head and a smoother response, and makes for easy fitting to the user.

Otarion's Rx-77 Target Hearing Listener, unlike conventional aids, has its microphone nestled in the nose bridge. Connection is made by wire to the rest of the aid contained in one temple bar. This approach helps the wearer distinguish the voice of a person facing

him from the babble in a room.

Telex' Radiant eyeglass hearing aid contains a tiny radio transmitter and receiver which eliminate the bother of removing the plastic conducting tube each time the glasses are removed. The transmitter, located in the temple bars, accepts the sound waves, converts them to electrical energy and broadcasts them through the air to the receiver which is located in the ear. The receiver picks up this signal, amplifies it and converts it back to sound waves in the ear canal. Six transistors are used: five in the transmitter section, which has a variable power output adjustment, and one in the detector type receiver, which does not need a separate switch.

Dahlberg's Clarifier reduces the size of the large paddle which fits behind the ear in conventional eyeglass aid to that of a regular eyeglass bow end by housing the batteries in the temple bar. Dahlberg's Super Optic-Ear provides extra power for more severe hearing losses. The earphone is worn in the ear, thus no air conduction tube is required. Since the earphone is separate, it can be selected to meet power level and frequency response requirements of the wearer.

Body aids must be used for the very hard-of-hearing. These units are usually worn on the body with a wire cable running to the earplug receiver. All now have separate on-off and volume control switches, most have avc circuits and some have filters built in to eliminate hum. Because of their gain and output power, these units generally can be adapted to either air or bone conduction requirements. Dahlberg's Super-6, which weighs 3¼ ounces, gets an average acoustic power output of 132 db with four transistors; it also has a two-position tone control. Telex' Model 67 uses a five-transistor push-pull circuit and variable reluctance type microphone. Sonotone's Golden 1000, a six-transistor model, has nine power settings.

An in-the-mouth hearing aid has been developed in Israel which is shaped like a pipe.[5] When held in the mouth, acoustic vibrations produced by the amplifier and transducer are transmitted through the teeth to the bone structure of the skull just as with bone conductor aids worn at ear level. Another type of jaw bone conductor is reportedly being developed in which the entire unit, including the battery, is mounted in a dental bridge.

Guidance Devices for the Blind—These aids are designed to help those people who, for all essential purposes, are blind. Although the practical application of these devices is nowhere near that of hearing aids, a number of techniques have been developed to solve this mammoth problem (see Table).[6]

One of the most difficult concepts for engineers to accept is that the limit of performance of these devices is not electronic, but psychological. Using a guidance device is roughly like walking about the deep woods on an extremely dark night with a pen-size flashlight for picking your way. Most of your information comes in discrete little packages—pieces of an overall-picture—which must be pieced together by scanning the area ahead.[17, 18]

One of the most important considerations is the method of communication with the user. Although the ear is capable of interpreting an extremely complex signal, auditory signals tend to rob the blind of a tremendous amount of information they normally receive through the ears. Tactile stimulation—vibratory, electric or pressure—does not provide as fine a discrimination as auditory stimulation, thus only the simplest signal can be interpreted.

Vision information is essentially in the form of a large number of channels in parallel, each channel having a minute bandwidth of at the most a few cycles per second. Audible information, on the other hand, must come through one single channel with a relatively large bandwidth (or, if counting both ears, two channels). The tactile sense, although it provides a multitude of channels, has a relatively smaller capacity.[16]

It has been fairly well agreed among investigators that an adequate guidance device should detect obstacles at least six feet ahead, large and small upward and downward discontinuities (stairways, holes, curbs, trees, cans, buildings and the like) and should give a good general orientation. With more hope than confidence, some researchers even want a device which will provide at least some degree of patterned information, that is, a plan-impression good enough to be useful in identifying objects and in forming a mental construction of the environment.

There are disadvantages to all the systems shown in the Table, the most severely limited appearing to be the sonic and ultrasonic devices. Radio frequency devices using radar-like echo return principles are doomed to failure because of the short distances involved and the high transmission speed of electromagnetic waves. The Franklin Institute, however, has utilized the proximity effect in developing an electronic cane designed to detect step-downs only (see cover). With this device, the user has all the advantages of a conventional cane but does not have to touch it to the ground.

Initially the operator holds the tip of the cane about two inches above the ground. A shielded wire extending the length of the cane and bared at the tip is used in conjunction with a 2-Mc oscillator to measure the capacity to ground. By adjusting a control in the handle and listening for a beat frequency null with an earphone, the operator tunes a second 2-Mc oscillator to the same frequency as the first. As long as the cane is kept the same height above ground, no stimulus signal is generated. However, if the cane passes over the edge of a curb, the distance to ground suddenly increases and the capacitive effect between the end of the cane and the ground changes abruptly. The difference frequency generated by this change is detected, amplified and fed to the earphone which produces a warning squeal or whistle. The detected signal can also be sent through two additional power amplification stages and used to energize a small motor. An eccentric pin driven by the motor gives a tactile warning signal by vibrating the hand. One hundred prototype units are being made by General-Dynamics/Electronics and will be tested by the Department of Health, Education and Welfare's Office of Vocational Rehabilitation.

Visible light, ultraviolet and infrared devices are all limited by the interference of ambient energies

existing at their wavelengths. It may be possible to overcome this difficulty in visible light systems with the modulating technique used in the Signal Corps device.

Most promising system is an improved version of RCA's optical device which is being researched under a Veteran's Administration contract. Laboratory development is being done by Biophysical Labs and final evaluation by Haverford College.[14, 15] To date, a two-range and a three-range system have been built; the only functional difference between them being that an integrating circuit is used in the three-range system to increase sensitivity of the device for middle and far ranges. The optical principle of range determination by triangulation is shown in Fig. 3B. A light beam from the source is focused by the source lens on an obstacle. Unless the obstacle has a very shiny surface, a small amount of light will be reflected from it in all directions; thus a pencil of rays is always running through the center of the receiver lens regardless of the position or angulation of the obstacle. Location of the image with respect to the lens axis is a measure of the distance to the obstacle. Although range can be discriminated only crudely, it is adequate for a guidance detector.

The two-range device is shaped like an automatic pistol with an appended cartridge suspended from the barrel (see Fig. 3A). The pulse generator produces pulses 220-250 microseconds wide at a rate of 22 a second. These pulses are amplified and used to excite a xenon lamp, causing light flashes of the same duration and frequency as the initiating pulses.

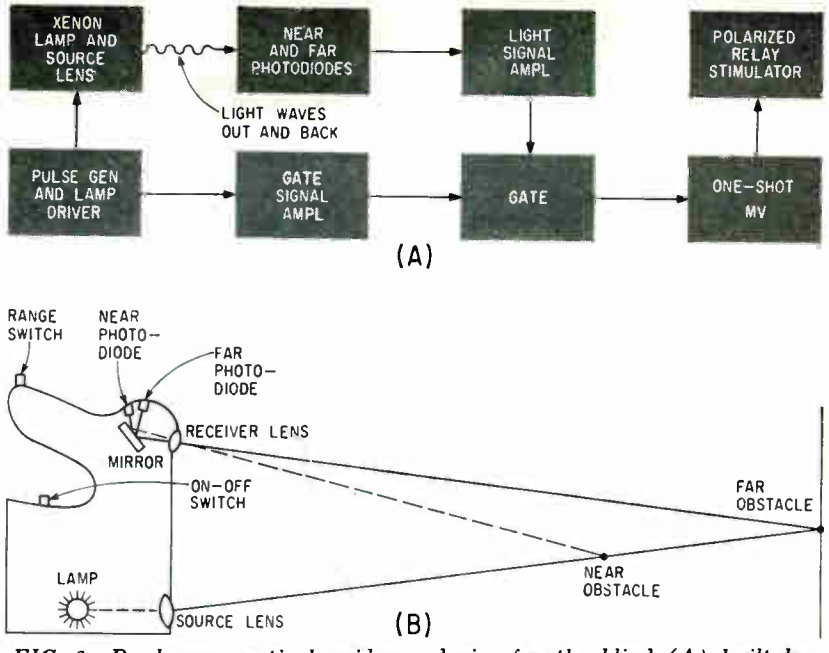


FIG. 3—Dual-range optical guidance device for the blind (A) built by Biophysical Labs. Triangulation principle used for range determination is shown in (B)

The source lens focuses the light into a beam. Reflections from obstacles are caught by the receiving lens and focused on a pair of photodiodes, the far and the near diodes, which are mounted at focal points corresponding to far and near ranges. Both diodes are active unless the range switch is pressed whereupon only the near diode remains active. After amplification by the light signal amplifier, the signal is fed to a gate. Output pulses from the pulse generator are amplified by a gate signal amplifier and applied to the gate to open it at the correct moment to receive any pulse from the light signal amplifier. The gate is closed at all other times to discriminate against interference from spurious light from other sources. When large enough, the light signal from the gate triggers a one-shot multivibrator which drives the stimulator, a small rod driven by a solenoid, that gives the user a poke each time a light signal passes through the gate.

The three-range detector uses three photocells as light receivers. They are placed behind the receiver lens at appropriate positions to detect obstacles in three ranges centered at 3 ft, 5 ft and 7 ft. Electrical output from each diode is passed through a separate amplifier that actuates a stimulator in the handle. Integration circuits increase the sensitivity for the middle and far ranges.

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Satellite Sounder and Telemeter

Describes measurement and telemetry problems unique to this satellite-borne

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KNOWLEDGE of the electron density profile above the uppermost F-layer of the ionosphere will help solve space-communication problems and extend fundamental knowledge of the origin and structure of the earth's ionospheric envelope. Clues to the origin of such phenomena as spread-F, sporadic-E, the Van Allen belt, or aurora may well be hidden in the upper ionosphere. A knowledge of ionospheric electron density at all altitudes is also essential for the determination of refraction and multipath effects, polarization rotaiton, severity of vehicle-induced plasma sheaths, antenna perturbations and other considerations.

The satellite ionosounder discussed here will soar over the earth in a polar orbit to record the magnitude of the reflected returns from the ionosphere, as well as their time delays, so that eventually a complete latitude-time-dependent electron-density profile will be obtained. This ionosounder can also detect a natural or artificial disturbance in the ionosphere.

A discrete point of the ionosphere will reflect a vertically incident wave of a critical frequency, this critical frequency depending on the free-electron density at the point. An ionosounder is a vertical h-f radar that determines the heights at which the ionosphere reflects ionosounder pulses of differing frequencies. Height-frequency data obtained by the ionosounder is used to calculate electron densities. Radar range to the reflection points is called the virtual height; this height is somewhat greater than the true height of reflection since r-f pulses travel slower in the ionosphere than they do in free space. Because of the effect of the earth's magnetic field, a transmitted wave generally is split into two modes of propagation, the ordinary and extraordinary; hence there are two returns for each pulse sent into the ionosphere. For a given electron density, the critical frequency of the extraordinary ray is somewhat higher than that of the ordinary ray, the frequency difference depending on the earth's magnetic field. Polarizations of the two rays are nearly left and right circular over most of the earth. The conventional ground sounder is a continuously swept-frequency device which gives continuous traces of the two rays on a virtual-height-versus-frequency plot. This permits identification of the rays since an extraordinary wave penetrates the ionosphere at a higher frequency than an ordinary wave. The curve of Fig. 1A was based on data averages for a summer noon at middle latitudes and a sunspot maximum.

Ground-based ionosounders usually require considerably more than 1 Kw of power and use large fixed broadband antennas, as well as numerous components unreliable in a space environment. The engineering problems of designing a topside sounder are concerned with approaching the capability of a ground sounder, with the additional requirements of having low input power, high reliability, easily erected antennas, and command, storage and telemetry systems.

There are also unique problems with the topside sounder. While the ground sounder operates in a virtually ion-free environment, the topside sounder must operate in the ionosphere that it is measuring. This raises problems in data reduction as well as in the design of the sounder.

The requirement for reliable, easily erected antennas prohibits the use of broadband antennas. This limitation and the reliability requirement prohibit the use of a swept-frequency, continuously operating sounder. Therefore, a stepped discrete-frequency transmitter is used.

One of the sounder's requirements is to measure the ionospheric profile at times of solar flares and bursts. Hence, pulse power of the sounder must be high enough to yield a usable signal-to-noise ratio at times of maximum solar noise. Figure 1B shows the maximum total cosmic noise and solar noise expected at the topside of the ionosphere. Factors such as the loca-

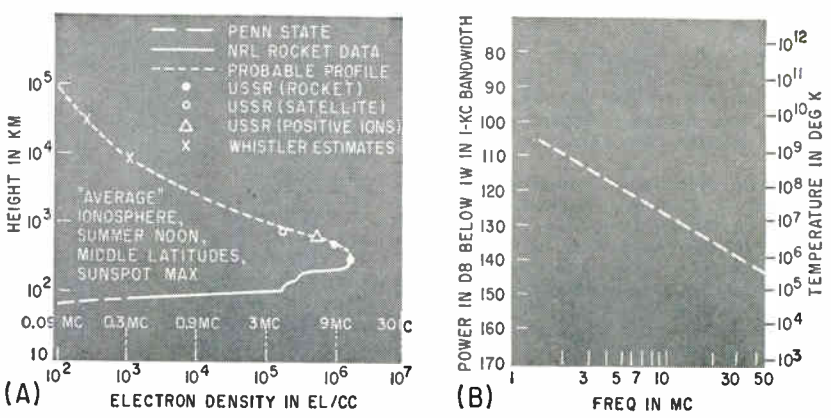


FIG. 1—Data for electron-density curve (A) is from several sources. Predicted maximum solar and cosmic noise for 2,000-Km satellite (B)

Chart Ionosphere Electron Density

ionosounder and goes into the details of the h-f transmitter's power amplifier

tion of radiation belts, telemetry viewing time, and coverage areas dictate orbit location. The planned circular orbit (see ELECTRONICS, June 16, 1961, p4) is nearly polar to cover the geomagnetic poles and is at 2,000-Km altitude.

Thus, certain broad requirements may be enforced on the system design. The necessity of using fairly high pulse power, while maintaining low average power input for a low duty cycle pulse system makes a transistor h-f sounder transmitter most attractive. At present the highest-power h-f transistor available is the PT 901. Its capability of 150 w pulse power at the lower h-f frequencies sets an upper power limit on the h-f sounder transmitter.

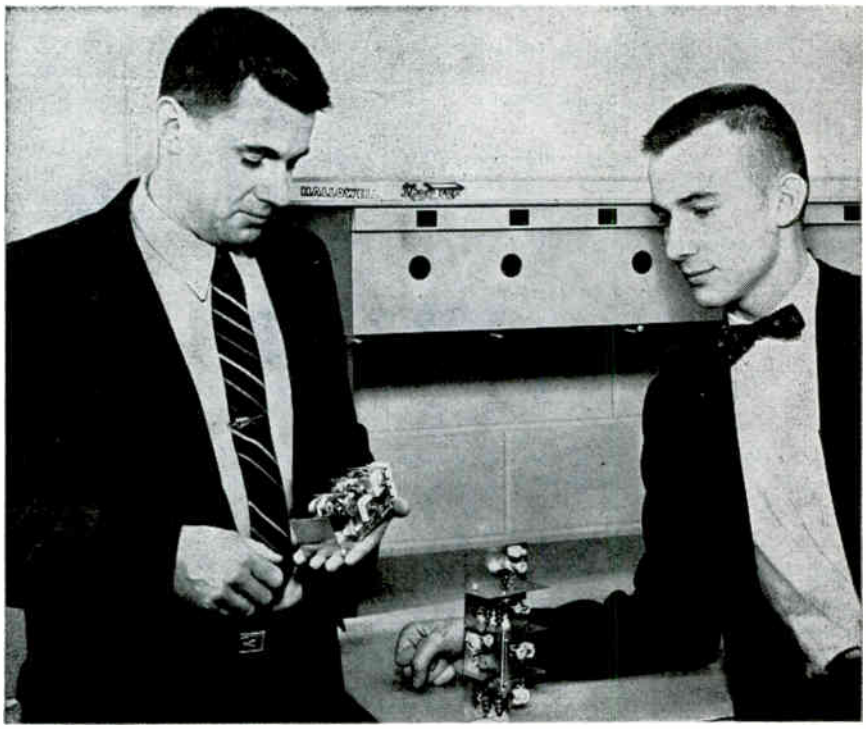
The maximum frequency is set by the highest ionospheric penetration frequency and the lowest frequency is limited by antenna size and configuration; the highest penetration frequency expected is 15 Mc, while antenna and detuning factors set a 3-Mc minimum frequency. Data-analysis considerations lead to a logarithmic frequency spacing resulting in sounder frequencies of 3, 4.2, 5.7, 8, 11 and 15 Mc.

The minimum pulse width is determined by the bandwidth of the receiver. For a peak power of 75 watts radiated the bandwidth for a suitable S/N is 2 Kc, which corresponds to a 500-μsec pulse width.

To minimize detuning, an unloaded antenna Q of 20 is required at the lowest frequency. To minimize pattern deterioration, antenna length should not exceed a half wavelength. For resolving the two propagation modes, a circularly polarized receiving antenna is desirable.

For deployment of large h-f antennas and for their maximum use, a three-axis stabilized vehicle is required. This in turn dictates the heat-balance requirements of the vehicle.

Since world-wide coverage is desired, data must be recorded and played back at an interrogation station. The record time and time compression are set by the orbit parameters and the location of the interrogation station. The record response is essentially that of the h-f receiver. Playback response equals the record response multiplied by the compression ratio (which is set at ten for a 2,000-Km orbit with a single readout station). The telemetry bandwidth is the same as the recorder play-



At left is the all-transistor power amplifier of transmitter and at right is the all-transistor receiver

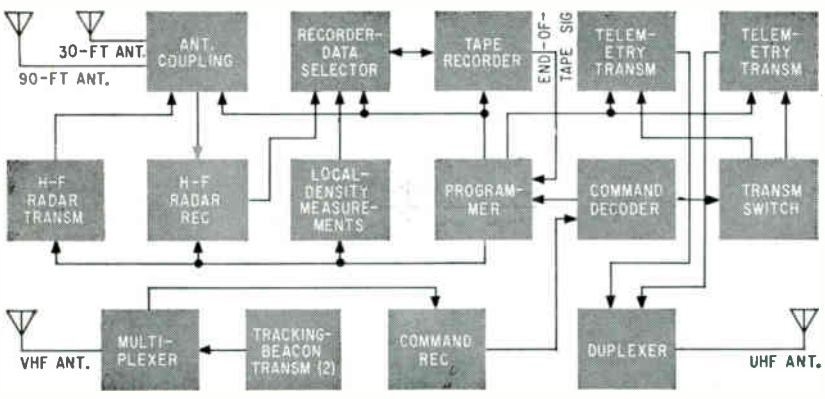


Fig. 2—The 90-ft and 30-ft antennas of ionosounder are both dipoles. Both antennas' coupling networks are sequentially stepped in frequency

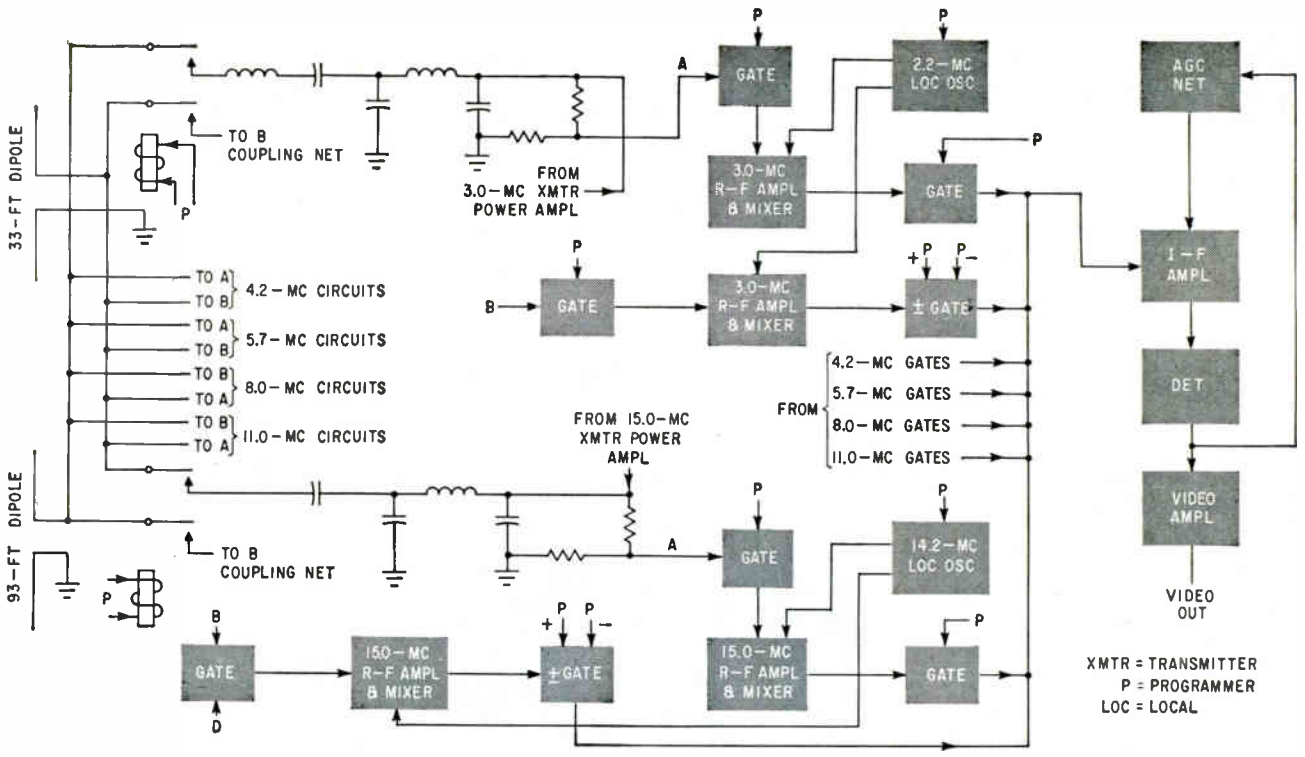


FIG. 3—Partial diagram shows how programmer signals (P) control antenna-coupling and receiver-gating circuits. Not shown here are transmitter gate circuits by which programmer controls transmitter power to antenna coupling circuits

back figure. Solar cells can provide power for the system. Since the solar cell configuration for continuous operation would be prohibitively large, ground commands initiate and stop recording and playback.

The h-f radar transmitter (Fig. 2) operates sequentially on six frequencies between three and 15 mc, pulsing 20 times on each frequency, then shifting to the next frequency in sequence. It uses transistors throughout and has a power input of 1.5 watts.

The radar receiver combines signals from two dipole antennas in phase quadrature to respond to left and right-hand circular polarization selectively. After the first ten pulses on a single radar frequency, the receiver is switched to respond to the opposite sense of phase rotation for the succeeding ten pulses. Each frequency channel of the receiver contains two identical r-f amplifiers and mixers, together with a common local oscillator whose signal is injected into each mixer in quadrature with the r-f signals from the antennas. The outputs of all frequency channels go to a single i-f amplifier, detector and video amplifier. The receiver noise figure must be sufficiently low to keep receiver noise substantially below the minimum cosmic noise at the receiver input.

The programmer translates operating mode information from the decoder into sequencing and timing for the equipments in the satellite. Accurate time reference is provided by a 400-cps tuning fork oscillator having a frequency accuracy of better than 0.05 percent over the encountered temperature range. The programmer provides for seven modes of operation, its weight is about one pound, and its power drain about one watt.

A command receiver in the satellite accepts pulse-position-modulation signals that are transmitted by the ground station, and which control the operating modes of the satellite equipment. Four information bits can be transmitted over this channel, giving a capacity of 16 different operational commands, of which only seven are actually used. Estimated weight of the command decoder is four ounces or less.

The radar antennas are two crossed dipoles. One dipole at a time transmits; in the receiving mode, reception from both antennas is combined. The longer of the two dipoles is used when transmitting on the lowest three frequencies, while the shorter dipole is used when transmitting on the higher three frequencies. Both dipoles will be erected and made rigid

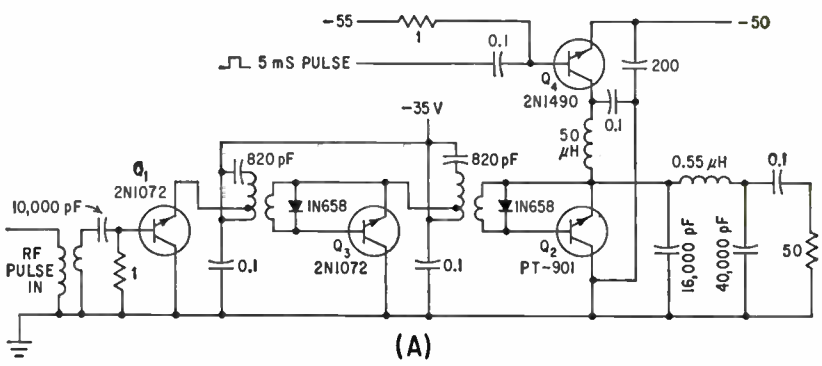


FIG. 4—Transmitter r-f power amplifier (A) also appears in (B), which

after the satellite is stabilized in orientation.

The external configuration of the satellite vehicle is primarily determined by the solar cell array area and vehicle heat balance control of the solar power supply.

The h-f receiver is an electronically switched, solid-state, multiple-frequency single-conversion superheterodyne. The sense of the circularly polarized reception is obtained by combining the weighted outputs of two crossed-dipole receiving antennas in phase quadrature; the sum of the two gives sensitivity to one sense, or direction of rotation, and the difference gives sensitivity to the opposite sense. Gain of two receiving antennas must be compensated because the long and short dipoles have different gain-frequency characteristics.

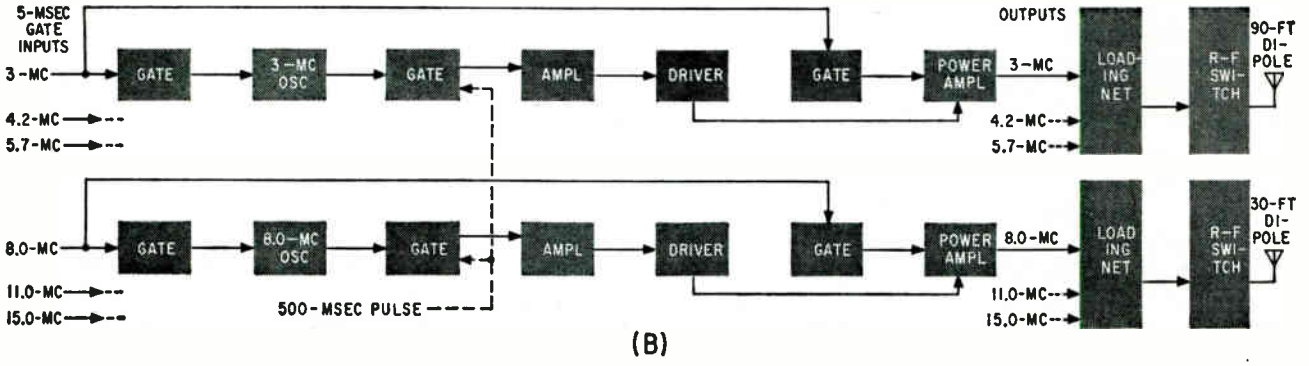
Figure 3 shows the h-f receiver and the antenna coupling circuits. Each of the receiver inputs (*A* and *B*) comes from a coupling network that is connected to the antenna switching circuit. The gates preceding the common i-f amplifier combine the outputs from the two mixers, either in phase or out of phase, to determine the sense-of-polarization rotation. Each local oscillator has two outputs, in quadrature, producing a 90-degree relative phase shift between the signals from the crossed-dipole antennas. The i-f amplifier operates at approximately 800 Kc, with a three-db bandwidth of 5 Kc. The agc network operates on the rectified noise, which is integrated with a time constant of 20 msec. Noise level at the input to the video amplifier is kept nearly constant so that all video signals are referenced to the extraterrestrial noise level. The video amplifier has a linear dynamic range of approximately 20 db and compresses the next ten db into a five-db spread. The agc keeps noise output constant to approximately six db, over a 30-db input noise variation. The video amplifier limits bandwidth to approximately 1.2 Kc at the 3-db point and amplifies the video signal to the level for recording and telemetering.

The radar power amplifier delivers r-f pulses to the antenna loading network. These pulses have a peak power of about 150 watts and a pulse length of 500 μsec. The PT-901 transistor is the active element in the radar transmitter. An unusual deviation from commonly observed silicon transistor characteristics is noted in the PT-901; collector cutoff has a typical value of 40 ma at 60-v collector-to-base voltage. For the extremely low-duty-cycle operation envisioned in the sounder transmitter, the cutoff current drain would be excessive if the nonoperating transistors were not disconnected from the high-voltage power supply. Therefore, an additional semiconductor switch must be used on each power amplifier to supply high voltage when that amplifier is being operated.

Since the collector of the PT-901 is connected physically to the case and mounting stud, the d-c potential of the power amplifier's collectors is at ground (Fig. 4A). However, all stages except the first stage (Q_1) have common-emitter a-c circuits. The amplifier was driven from a pulsed laboratory oscillator, using pulses in the range 100-500 μsec. The optimum tuned-load impedance for a PT-901, for maximum class-B power output, is 6.67 ohms. The π network at the output transforms a 51-ohm load to the required impedance for loading the transistor. The class-B final amplifier (Q_2) was driven by Q_3, a stage capable of approximately 15 watts peak power output. With the amplifier operating at 2.2 Mc, a power output into the 51-ohm load of 105 watts has been achieved. The efficiency of the π network was approximately 70 percent, so that the transistor was delivering a peak power of 150 watts. Transistor Q_2, which was powered by a 50-v supply, had a peak collector-to-emitter voltage of 93 volts and a peak collector current of 15 amperes.

The h-f radar transmitter (Fig. 4B) includes six crystal oscillators, one for each sounder frequency. Each oscillator is controlled by a 5-μsec gate and is followed by a 500-μsec gate. By gating the oscillator approximately 5 μsec before the start of the pulse, oscillations are allowed to build up. After the 500-μsec transmitter pulse, the oscillator is gated off to avoid blocking the radar receiver during reception of ionospheric echoes. The gated output of the oscillator feeds an intermediate amplifier stage, followed by a driver, which drives the final PT-901 r-f power amplifier. The 5-μsec gate supplies power to the amplifier. Output of the r-f power amplifier is coupled to the antenna through an r-f switch and loading network. Switching is done at a low impedance point in the network to avoid switching high r-f voltages at the antenna terminals.

Work was performed under contract AF 19(604)—7221, AF Cambridge Research Laboratory.



shows partial diagram of h-f radar transmitter. Only one antenna transmits at a time

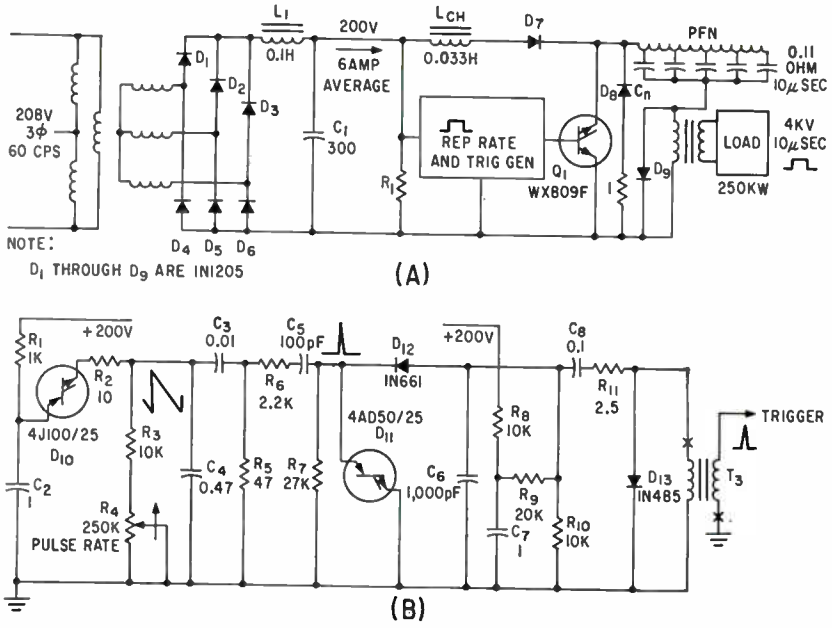


FIG. 1—Simplified schematic of a 250-Kw, 360-pps, 10-microsecond pulse width solid-state modulator (A), and trigger generator (B)

Controlled Rectifier Produces Quarter-Megawatt Pulse Power

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USE OF SOLID-STATE devices to replace thermionic and gaseous vacuum tubes in line-type modulators and associated power supplies and trigger circuits reduces size, weight and cooling requirements, and increases system efficiency, reliability and serviceability. An all solid-state modulator that produces a peak power output of 250 Kw is shown in Fig. 1A. This modulator uses silicon diodes for high-voltage rectifiers, backswing, hold-off and inverse-diode circuits. The switch is a *pnpn* silicon-controlled rectifier. The trigger generator uses two-layer and four-layer diodes.

The power supply consists of the plate transformer, silicon-diode rectifiers D_1 to D_6, ripple filter L_1 C_1 and bleeder resistor R_1. Both L_1 and C_1 may be eliminated if the pulse rate of the modulator is constant, is some multiple of, and is synchronized with, the power supply frequency. Diode D_7 permits operation over a wide range of pulse repetition frequencies.

Charging inductor L_{ch} and pulse-forming-network (PFN) capacitors C_n permit resonant charging of C_n to twice the supply. The value of L_{ch} is determined by the requirement that $\pi \sqrt{L_{ch} C_n}$ be less than the interpulse period. Diode D_7 isolates the PFN capacitors from the power supply until the modulator is triggered. It is, therefore, possible to trigger the modulator in synchronism with any pulse train or random pulse group whose minimum interpulse period is compatible with the resonant charging. A positive trigger signal, derived from a source impedance of 100 ohms or less, and having a rise time of 1 to 20 v/nsec, applied to the gate electrode of Q_1 switches the controlled rectifier. The fast trigger from a low-impedance source forces Q_1 to turn on so as to permit exceedingly high current operation. Average current rating of Q_1 is only 50 amperes. However, it will operate on short pulses at peak currents as high as 5,000 amperes.

Duty cycle of this pulser is limited by the average power rating of Q_1. Pulse width and repetition rate are not directly interchangeable in this modulator as the instantaneous power loss of the switch, which produces device heating, is a decreasing function of increasing pulse width. Therefore, the highest peak and average power outputs are obtained with pulse widths in excess of 10 microseconds.

Rise and fall times of the output pulse may be degraded for short pulses by the turn-on and turn-off characteristics of Q_1. Figure 2A shows the pulse output obtained from the modulator with a 30-microsecond, 10-section pulse line. Calculated 10 to 80 percent rise and fall times of this pulse were respectively 1.5 and 3 microseconds; observed rise and fall times were 1.5 and 20 microseconds. The discrepancy is due to device characteristics.

Initial turn-on time and time jitter of the modulator output pulse were measured using the trigger as a reference. Figure 2B, which displays these signals as averaged over 100 pulses, shows no time jitter when either a 20-nanosecond jitter or delay could easily be resolved. No observable delay occurs between the trigger and the start of the output pulse. Low jitter and fast initial turn-on result from triggering from a low-impedance source.

Rectifier Q_1 must pass extremely

high currents and recover to the high-impedance state within microseconds. As Q_1 forms a short circuit across the power supply through inductor L_{ch} during the pulse, current builds up through Q_1 to a level approximately $\Delta I \cong E \Delta t/L_{ch} \cong (300)\ (5 \times 10^{-7})\ /0.1 =$ 150 ma. To insure that Q_1 turns off at the termination of the pulse, it is necessary to coordinate the choice of L_{ch} with the thyratron holding current. Alternatively, an induced load mismatch would cause an inverse voltage to appear across Q_1 at the termination of the pulse. Regardless of the mechanism used, it is necessary that current through Q_1 be reduced to a value below its holding current level for the modulator to operate.

For effective use of the inherent high-power switching capabilities of Q_1 a low-impedance PFN is required. Pulse lines of conventional design have been tested at impedance levels as low as 0.1 ohm. Parallel pulse lines may be used to achieve lower impedances. Care is needed in the selection of low-inductance, low-loss capacitors for the construction of such PFN's, as the rms currents become large and may result in considerable capacitor heating. Mylar rather than Kraft paper dielectric capacitors are desirable. Capacitor cooling requirements are largely dictated by duty cycle. Low-inductance low-resistance conductors should be used throughout the high-current discharge path to ensure that maximum voltage appears across the load.

To preclude collector triggered operation in this modulator, it is desirable to limit the power supply voltage to one-half the breakdown voltage of Q_1.

Repetition rate of this pulser may be increased markedly if the PFN capacitors are recharged from a pulse source. Disadvantages, however, include greater complexity, lower circuit efficiency and higher power-supply voltage. Pulse recharging of the network capacitors can be justified only where high repetition rates are desired. With pulse recharging, pulse burst repetition rates as high as 25 Kc may be obtained for pulse output currents of 1-500 amperes. At higher pulse-current levels in single units, lower repetition rates will be enforced by the longer turn-off time of Q_1.

Variable pulse width operation can be obtained if a second *pnpn* device is located at the opposite end of the PFN. The stop pulse, to terminate the output, is derived from the start pulse through a solid-state delay circuit.

To increase the pulse power output to and above the megawatt level, it is necessary to operate *pnpn* switches at high peak current levels. A device with an average current rating of 50 amperes can produce peak output current pulses of 2,000 to 5,000 amperes and peak output powers of megawatts. Units rated at 100 amperes are available and 200-ampere units are under development.

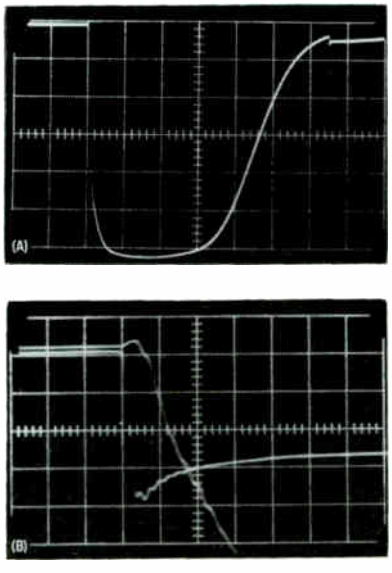

FIG 2—Modulator pulse output into resistive load (A) with a 10-section, 30-microsecond pulse line. Turn-on characteristics of pnpn device (B) averaged over 100 pulses; time scale is 200 nsec per cm; first pulse is trigger, second is pnpn response

Controlled rectifiers can be paralleled with balancing networks to achieve even greater power outputs per pulse. Experience, however, dictates that independent charging circuits and independent networks are more desirable where higher peak and average powers are required. Outputs of all of the networks are combined at the pulse transformer to produce a current pulse in the load. The short delay and low time jitter in the initial turn-on ensures that all parallel networks will operate in synchronism. In parallel operation, a single line modulator of shorter pulse length can drive multiple line modulators. As the output impedance of the solid-state modulator is only a fraction of an ohm whereas the required gate current of the solid-state thyratrons is of the order of milliamperes, many parallel circuits may be driven satisfactorily from a single high-power source.

The inverse, D_8, and backswing diodes, D_9, shown in Fig. 1A can be eliminated if the probability of load shorts is negligible. With an inverse diode circuit, sufficient inverse voltage must develop across Q_1 to initiate turn-off. The solid-state components used in the rectifier, hold-off, inverse and backswing circuits are conventional.[1]

The simplified schematic of the all-solid-state trigger generator used in this modulator is shown in Fig. 1B. This pulser uses the break-point of a four-layer diode D_{10} to determine the switching voltage. The time constant of the recharge circuit R_4C_4 determines, along with the holding current of D_{10}, the basic pulse rate. Output of this pulser is differentiated by C_8 and R_9 before being pulse-coupled to D_{11}. As four-layer diode D_{11} is biased near its break point, the differentiated positive output pulse from the relaxation oscillator initiates high-current conduction almost immediately; C_8 is discharged through T_8 by D_{11} to create a positive trigger pulse having a rise rate of 10 to 20 volts/nsec; T_8 is connected directly to the gate electrode of the *pnpn* solid-state thyratron. Diode D_{12} limits backswing during the pulse-transformer recovery.

Special problems arise in the use of this modulator as direct output voltages in excess of 250 to 300 volts cannot be obtained with single solid-state thyratrons. Higher than normal turns ratio pulse transformers are required for output voltages of 5 to 20 Kv. Their design is, however, straightforward as the source impedance is now extremely low.

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Random Pulse Generator Tests Circuits,

Shift-register generator uses high-speed logic in producing complicated pulse sequences up to 4 billion bits in length. Generator is used in tests that determine error rates of data-transmission systems and in high-security communication links where it produces an undecipherable and nonrepetitive modulating waveform

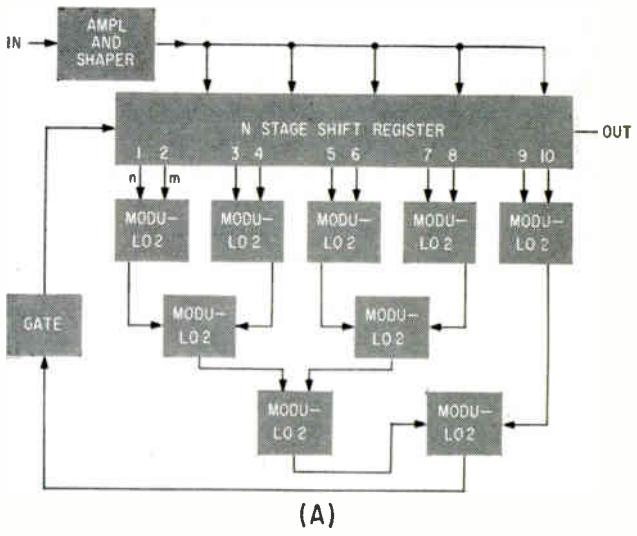

FIG. 1—Typical modulo-2 configuration of a conventional which is shown in (B), uses scanning technique in produc-

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RAPID EXPANSION of digital data transmission techniques has created a need for pseudo-random or linear sequence pulse generators. These generators deliver pulses that seem to be randomly spaced in time. Even for a nominal number of shift-register stages, these pulse sequences must be examined over a long period of time before periodicity can be detected. Such circuits are used in tests that determine error rates in data transmission systems[1], and as the modulating waveform in high-security communication links[2].

To generate such pulse sequences, combine pairs of outputs from several stages of a binary shift register into a complex of exclusive-or logic circuits and feed the result to the first register stage as a reset pulse. An exclusive-or circuit gives an output when either, but not both, inputs are activated. This logical operation is sometimes described as modulo-2 addition and may be performed with any number of inputs. This paper describes a technique which circumvents the complexity and large number of components used in conventional multiple-input modulo-2 circuits. The maximum length of the sequence generated this way is $2^N - 1$ where N is the number of stages in the shift register.[3]

The operation of a four-stage shift register is indicated in the table. Here the outputs of stages three and four are modulo-2 added to determine whether a 1 or a 0 is shifted into stage one as the register information is sequentially shifted to the right. The output of any stage (reading vertically between bit times 1 to 15) comprises the maximum sequence that is possible for a four-stage register; the sequence resumes at bit time 16. It may be necessary to modulo-2 add the outputs of more than 2 stages to achieve the maximum length sequence, or other desired sequences, where a large number of stages are used.

The improved sequence generator contains approximately 30 shift-register stages, has a maximum shift rate of 1.5 Mc, with a 10-input modulo-2 adder in the feedback path, and can connect any of the 10 modulo-2 inputs to any of its 30 or more shift register stages. The maximum sequence length for 30 stages is over one billion bits.

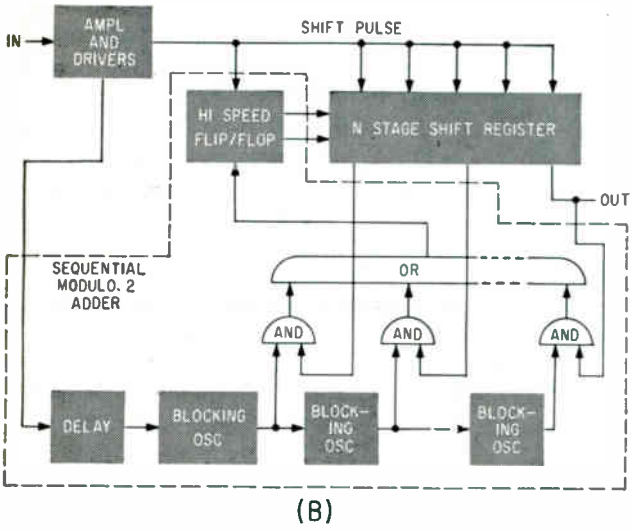
Figure 1A shows the block diagram of a binary sequence generator having a typical modulo-2 configuration. Its 2-input modulo-2 adders are cascaded to achieve the desired 10-input modulo-2 addition. The input is a shift pulse at any arbitrary frequency up to the maximum rate and the output-pulse sequence may be taken from any stage of the shift register. Each modulo-2 adder performs logic on stage outputs m and n thusly:

$$X = m\,\bar{n} + \bar{m}\,n$$

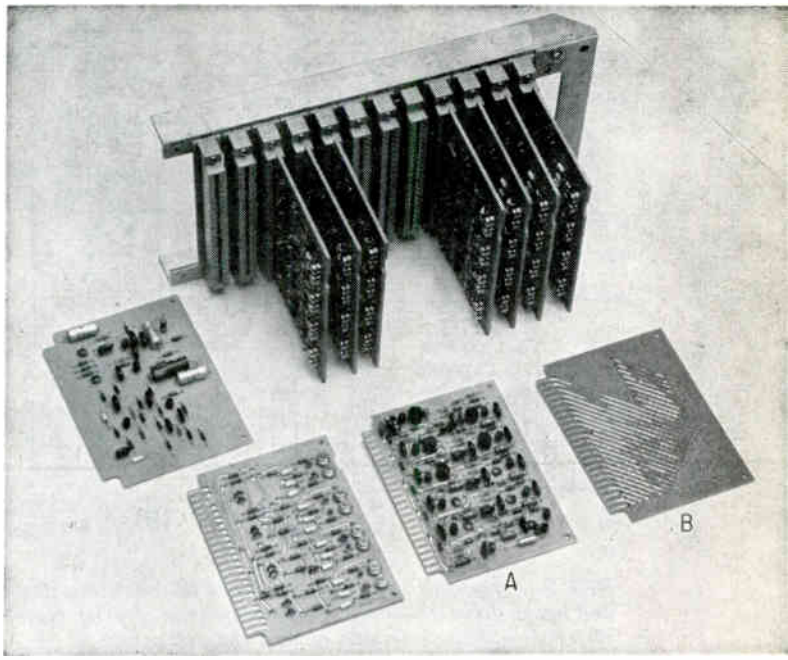
where X is the desired output. The complements of m and n are taken from the shift-register stages. Thus, 20 connections between the modulo-2 adders and the shift register are required for this conventional approach. Numbers 1 to 10 represent any desired set of 10 stages of the shift register.

The modulo-2 adders must include an inverter to provide the complement of the function to drive the following modulo-2 adders. The interval of time available for performing the logic is $1/f_s$ where f_s is the maximum shift frequency, about 700 nanoseconds. Allowing 300 nsec to operate a transmission gate between the final modulo-2 adder and the first shift-register stage leaves 400 nsec to perform

Encodes Messages



sequence generator (A). The improved sequence generator, ing modulo-2 additions



Partial assembly of shift-register sequence generator. Letter A indicates card of blocking oscillators and diode logic and letter B indicates interconnection board

the entire modulo-2 addition, which corresponds to 100 nsec per modulo-2 logic level. Thus, each modulo-2 adder and inverter would have to give no more than 100 nsec delay. Figure 1A would require 6 diodes and 2 transistors per stage (one transistor to regenerate the logic levels and one for the inverter), a total of 54 diodes and 18 transistors.

Figure 1B shows the improved approach. This sequence generator performs a 10-input modulo-2 addition with fewer components and connections than the Fig. 1A generator. The improved method is based on the theorem

$X_1 + X_2 + \ldots + X_n = 0$, if the number of terms is even, and $X_1 + X_2 + \ldots + X_n = 1$, if the number of terms is odd

when X_n corresponds to the 1's presented to the multiple-input modulo-2 adder; here + represents summing modulo-2 outputs. Thus, if the shift-register stage outputs are sequentially scanned to perform a parity check, a modulo-2 addition is performed.

The blocking oscillators generate a sequence of pulses spaced 40 nsec apart and scan the shift-register stages. The state of the shift-register stages determines whether or not the blocking-oscillator pulses will be fed to the high-speed (25 Mc) flip-flop. It will take a total of 40 nsec × 10 = 400 nsec to complete the scanning operation. The

OUTPUT STATE OF 4-STAGE SEQUENCE GEN

TIME STEP	STAGE NUMBER 1	2	3	4
1	0	1	0	0
2	0	0	1	0
3	1	0	0	1
4	1	1	0	0
5	0	1	1	0
6	1	0	1	1
7	0	1	0	1
8	1	0	1	0
9	1	1	0	1
10	1	1	1	0
11	1	1	1	1
12	0	1	1	1
13	0	0	1	1
14	0	0	0	1
15	1	0	0	0
16	0	1	0	0

One's and zero's in the table indicate the states of the four stages. Information is shifted to the right, that is, from stage to stage, at successive time steps. For example, the one that is held by stage 2 at time 1 is shifted into stage 3 at time step 2.

The presence of a one in either stage 3 or stage 4 causes a one to go into stage 1 at the next time step. For example, in time 3, stage 4 holds a one; thus, a one goes into stage 1 at time step 4

state of the high-speed flip-flop at the end of the sequence of pulses is determined by whether or not there were an even or odd number of 1's present at the shift-register stages being monitored. Consider, for example, a three-input modulo-2 adder. If all three adder inputs are 1's and the high-speed flip-flop is reset to the 0 state initially, the flip-flop ends up in the 1 state. The same is true if only one input is in the 1 state. However, if two inputs are in the 1 state, the high-speed flip-flop will end up in its original state, the 0 state; thus, the circuit functions as an n-input modulo-2 adder.

This approach requires only 10 connections between the shift register and the modulo-2 adder as compared to 20 in the conventional approach. However, the method of Fig. 1B requires a 25-Mc flip-flop, fast logic diodes and a generator of 20-nsec-wide pulses spaced 40 nsec apart. If blocking oscillators generate the pulses, the sequential-scanning approach requires 13 transistors and 35 diodes.

The shift register is a thirty-two-stage asynchronous register composed of Eccles-Jordan flip-flops and conventional transmission gates between stages. Two blocking oscillator pulse generators,

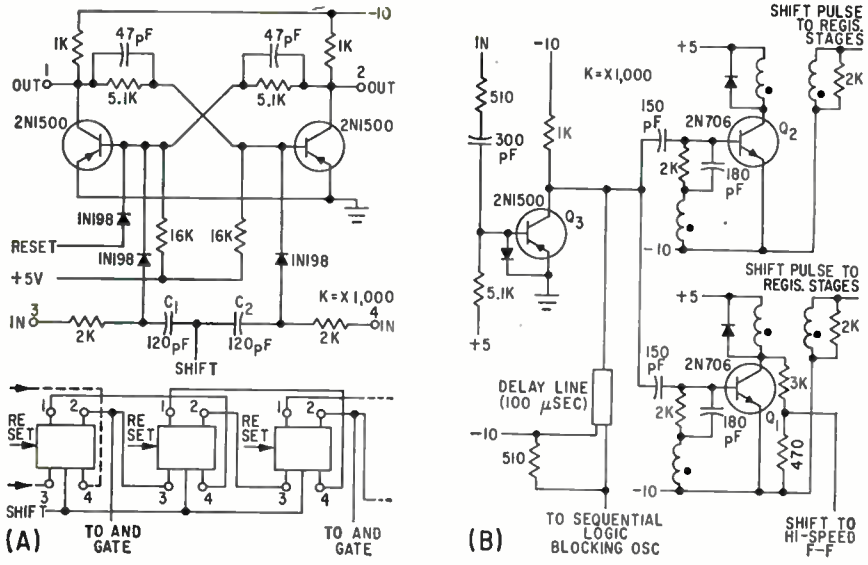


FIG. 2—Upper drawing of (A) shows the basic flip-flop of the shift register and lower drawing shows interconnections of shift-register stages. Inverter (B) pulses drivers Q_1 and Q_2 and the delay line

each driving 16 stages, drive the register, whose 1st stage is the high-speed flip-flop.

Each flip-flop stage (Fig. 2A) supplies 10 ma when turned on and approximately 0.6 ma when turned off for worst case voltage and resistance tolerances of 5 and 10 percent, respectively. A minimum β of 18 is required, and the operating temperature range is from zero to 55 C. The design was accomplished by using a digital computer program which gave a minimum-dissipation flip-flop.

All thirty-two stages are identical, with the exception of the 1st and 2nd stage. In the 2nd stage it was necessary to choose trigger capacitors of 82 pf so that the gating resistors (which come from stage 1, the high-speed flip-flop) could be as large as 2,700 ohms without having a prohibitively large recovery time before the next shift pulse. The 2,700-ohm value of the resistors was needed to prevent false triggering of the high-speed flip-flop from the shift pulse. Either a decrease in maximum operating frequency (1.5 Mc) or a decrease in the number (10) of modulo-2 logic inputs would allow stage 2 to be designed identical to the following stages.

The relatively large (120 pf) capacitances of the C_1's are necessary because of a possible 60-pf wiring capacitance at the output of each flip-flop. Approximately the same trigger charge is needed to drive this load capacitance as the trigger charge necessary to change the state of the loaded flip-flop. This is one of the main reasons that a low-capacitance matrix-type connection board is used to connect the shift register to the modulo-2 logic circuits. Conventional switching schemes such as toggle switches introduce too much capacitance for operation at these speeds.

Figure 2B shows drivers Q_1 and Q_2 of the shift register. Each 300-ma driver has a pulse rise time and width of about 10 and 50 nsec, respectively. Use of two drivers emphasizes the need for a pulse with a fast rise-time because all flip-flops in the register must be driven at approximately the same time. Blocking-oscillator analyses[5, 6] have shown that to achieve fast rise times the transistor gain bandwidth should be as large as possible; the $r_b'C_c$ product of the transistor should be as small as possible; the transformer should have minimum leakage inductance and stray capacitance consistent with the magnetizing inductance (L_m); and fast-rising trigger pulses should be used. Therefore, type 2N706 transistors were used and 3-winding torroidal transformers were designed using a high-frequency ferrite. These transformers have a bandwidth in excess of 200 Mc., leakage inductance of approximately 0.1 μh, and an open-circuit inductance of 1.0 μh.

The shift-register drivers are driven by an inverter circuit (Q_3) that shapes the input pulse and also provides an input to a delay line. This delay, approximately 100 nsec, allows the shift register stages to reach their final values in the new state before the sequential logic is initiated.

It is necessary to generate a series of 10 pulses approximately 20 nsec wide and spaced 40 nsec apart. A method of generating this sequence of pulses is to use ten delay lines and regenerate the pulse between each line. A blocking-oscillator configuration performs these functions (Fig. 3A). Most of the required delay is achieved by allowing each blocking-oscillator stage (Q_1's) to overshoot and trigger the following stage. A single LC section produces an additional delay. This results in smaller size and less weight—at about the same cost and with fewer components—than that achieved with a lumped-constant delay line. Resistor R_1 damps the circuit and prevent further oscillations other than a negative pulse with a single positive overshoot. The transformer was wound on a ferrite core with L_1 = 24 turns and L_2 = 12 turns. The single LC section provides about 5 nsec delay and sufficient isolation between stages for operation.

Ten two-input AND gates (D_1 and D_2) and one ten-input OR gate (D_3's) scan the shift register stages. A 1 is defined as a negative voltage and a 0 as ground level. The blocking oscillator produces a negative pulse, fed through the OR diode. The AND gate is operated at a 10-ma level to reduce the effects of diode and stray capacitance. The OR-gate output is a 4-volt pulse fed to Q_2 a direct-coupled emitter follower. The emitter follower provides low output impedance to drive the high-speed flip-flop. Control of lead lengths to and from the emitter follower prevents oscillations. The layout of Fig. 3A is critical.

The high-speed flip-flop (Fig. 3B) has a 4-volt swing and a collector current of 15 ma. The trigger charge is

$$Q_T \approx \frac{I_c}{\omega\alpha_b} + \Delta V C_c = 86 \times 10^{-12} \text{ coulomb}$$

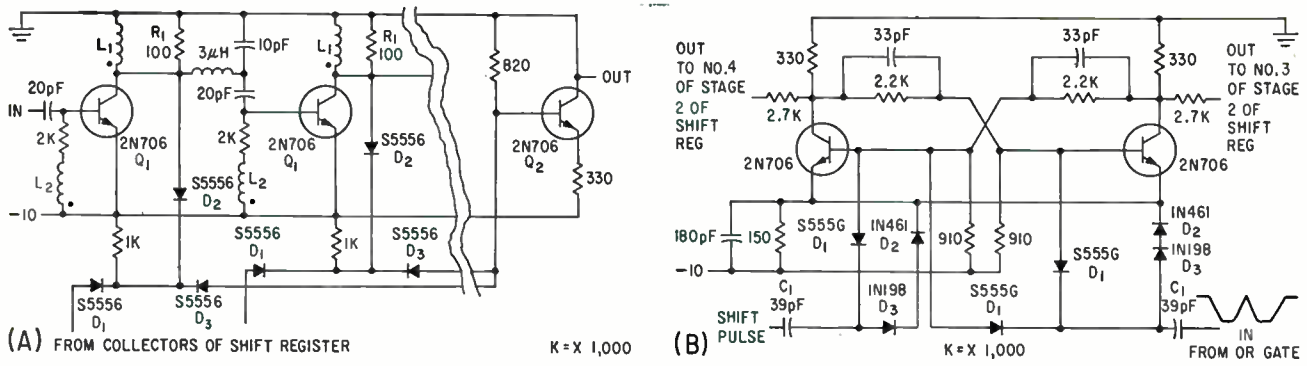


FIG. 3—Partial drawing of blocking oscillators and diode logic (A). State of high-speed flip-flop (B) is controlled by input from or gate

where I_c is the collector current, ΔV is the voltage swing, C_c is the effective collector capacitance, and ω_{ab} is the common-base cutoff frequency in radians. The trigger capacitor (C_1) is

$$C_1 = Q_T/(V_T - V_b) = 25pf$$

where V_T is the trigger voltage (4 v) and V_b is the trigger diode (D_1) drop. Adding a safety margin of 50 percent gives a value of about 39 pf. With this size capacitor, the time constant of a transmission gate with a resistor of reasonable size is too long for the repetition rate. Thus, it was necessary to use the base trigger gate shown. Two diodes in series (D_2, D_3) were required in each capacitor-discharge path due to the relatively large base-to-emitter voltage of the 2N706.

The modulo-2 adder as a unit was tested by feeding a pulse into the sequential pulse generator and allowing all 10 blocking-oscillator pulses to appear at the OR gate output. These pulses were fed into the high-speed flip-flop and the output of this flip-flop observed. The circuit operated correctly from −15 C to +70 C with a ±50 percent variation in the 10-v common supply.

Figure 4A shows a photograph of the modulo-2 adder output, taken at the flip-flop collector.

Due to the high-frequency circuits in this sequence generator, it is important to consider the stray capacitance in connecting the shift register collectors to the modulo-2 adder logic. Since the facility to connect any of the collectors to any of the modulo-2 adder inputs is required, the capacitance must be reduced. Any method using switches or relays or both would involve more capacitance than the circuits could tolerate. Thus, a printed-circuit board was used. One side of the board has lines connected to the shift-register collectors and the other side of the board has lines running at right angles to the shift-register-collector lines; these lines are connected to the modulo-2 adder inputs. Connections are made by soldering a pin to the two intersecting lines at the intersections.

A sequence of approximately 33,000 bits may be checked by using a Tektronix 545 cro equipped with a delayed sweep. An AND gate, connected to the outputs of the first 15 stages of the shift register, triggers the cro, which displays the register output pattern. Using the vernier delay dial on the cro, each bit of this long sequence may be checked. Figure 4B shows the output wave-form and the high-speed flip-flop waveform.

The sequence generator is capable of generating sequences over four billion bits long (2^{32}) before repetition of the sequence occurs. Thus, shifting at the maximum repetition rate of 1.5 Mc, the sequence takes approximately 40 minutes. The complete unit, consisting of 80 transistors and approximately 100 diodes, was successfully tested from 0 C to 50 C with ±20 percent variation in either or both power supplies.

The authors are indebted for the assistance of E. Fisch, W. Peil, and J. Suran in the electrical design of the generator and M. Hluchji in the mechanical design.

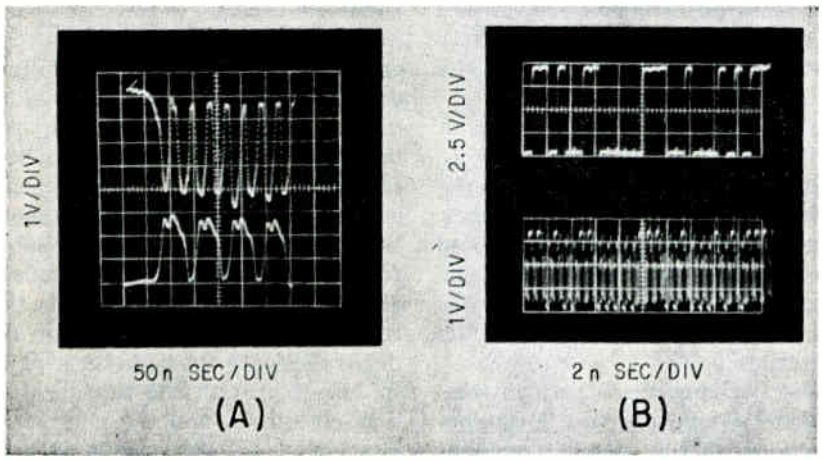


FIG. 4—Upper wave of (A) shows F-F input and lower photo shows wave at F-F collector. Upper wave of (B) is output code, lower wave is taken from the 25-Mc Flip-Flop collector

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Instrument measures water velocity over the range 2 to 200 cm per second from the speed at which the water turns a 1 cm diameter propeller

Measuring water velocity with portable propeller flowmeter

Portable Propeller Flowmeter Determines Water Velocity

By L. MOLYNEUX
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DURING zoological investigations, a portable device, capable of measuring water velocities from slightly less than 1 inch per second to approximately 6 ft per second was required. Previous devices used vacuum-tube circuits that required a power source and therefore were unsuitable for field use.

The portable device uses transistors, and since adjustments are difficult to make in the field, the circuit was designed so that adjustment for various conductivities of water are unnecessary.

Propellers for flow meters are made of an insulating material and run in jewel bearings. The bearings are supported by a metal frame mounted on the end of a narrow tube. A gold wire, insulated from the tube, passes down inside it and terminates about 0.1 mm clear of the propeller blades. As the propeller rotates, the impedance between the wire and the frame changes by a small amount each time a blade passes the tip of the wire. However, both the actual value of impedance and the magnitude of change depend on the conductivity of the water.[1, 2] In the circuit devised by Wilkie[3], the propeller head forms one arm of a bridge that is just off-balance for the conductivity of the water. The output of the bridge (a modulated wave) is then amplified, demodulated, and used to work a counting circuit. Previous circuits used vacuum tubes that required a power source and therefore were unsuitable for field use. The new circuit[3] uses transistors, and since adjustments are difficult in the field, has been designed so that adjustment for the conductivity of the water is unnecessary.

The circuit is shown in Fig. 1. Oscillator Q_1 supplies detector Q_2 with a 15 Kc signal that is amplitude modulated by the propeller. The output of the detector is filtered and amplified by Q_3 and Q_4 and then triggers bistable pair Q_6 and Q_7 that are coupled to a diode-pump integrator.

The detector circuit, which compensates for the changes in the conductivity of the water, works as follows: if other factors remain constant, the potential across the secondary of T_1 is determined by the impedance between the gold wire and the steel tube. This potential varies at the rate at which tips of the blades pass the end of the gold wire. The frequency at which these variations occur is called the rotor-tip frequency.

When Q_1 is oscillating, C_1 charges through D_1 to the mean value of the potential developed across the secondary of T_1. This potential, which is negative with respect to the neutral line, is applied to the emitter of Q_2. The secondary of T_1 is also connected directly to the base of Q_2; hence the potential between the emitter and base of Q_2 is the difference between the mean and instantaneous values of the secondary potential of T_1. The waveform of the collector current of Q_2 is then composed of current pulses with a repetition rate equal to the oscillator frequency (15 Kc). These pulses are amplitude modulated at the rotor-tip frequency. Capacitor C_2, in parallel with the collector load of Q_2, together with the tuned rejection circuit L_1 and C_3, eliminates most of the 15-Kc oscillator frequency component while leaving the rotor-tip component relatively un-

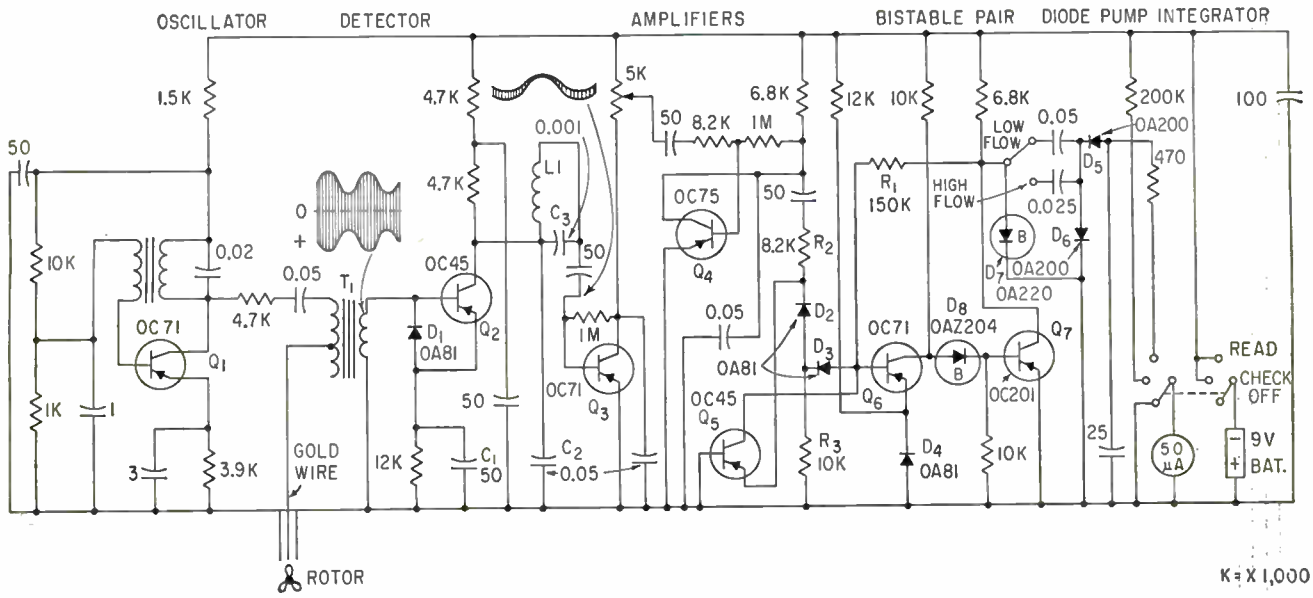

FIG. 1—Propeller amplitude-modulates a 15-Kc carrier by about 1 percent. After demodulation the signal at propeller frequency is rectified and integrated to drive velocity indicator

changed. The rotor-tip signal is then amplified by Q_3 and Q_4 until it is sufficient to trigger bistable pair Q_6 and Q_7.

The triggering action is as follows. With Q_7 off about 60 μa flows through R_1 into the base of Q_6, maintaining it on. If a current of 60 μa or more flows through R_2 in the positive direction (with respect to the neutral line), then current flowing through R_1 will be diverted to Q_5, thus turning Q_6 off. When Q_6 is off, Q_7 is maintained on by the current flowing through D_8. The emitter of Q_6 is maintained at about −0.5 v (with respect to the neutral line) by the potential drop across D_4. Transistor Q_6 can only be turned on if its base is made more negative than its emitter. Resistor R_3 ensures that this can only take place if more than 60 μa flows through R_2. The flow must be in the negative direction with respect to the neutral line. Thus, Q_7 is turned off if more than 60 μa passes through R_2 in the positive direction, and is turned on if more than 60 μa passes in the negative direction.

This trigger action distinguishes the rotor-tip signal from system noise. When Q_7 is on, the potential at its collector is virtually that of its emitter. When it is off, its collector potential is determined by zener diode D_7. The collector voltage waveform drives a diode-pump integrator, D_5 and D_6.

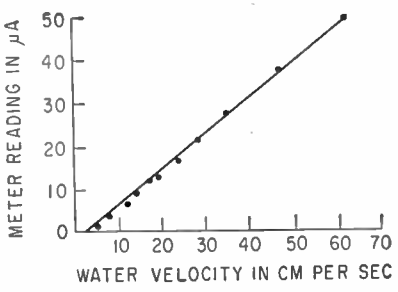

FIG. 2—Meter has linear calibration curve; origin displacement probably due to propeller friction

The flowmeter operates as a self-balancing, slide-back peak voltmeter, in which the reference potential across C_1 adjusts itself to nearly the peak value of the input waveform. The waveform applied to the voltmeter is modulated so that the peak amplitude (and the output of its detector) varies at the rotor-tip frequency. A change in the conductivity of the water will change the peak value of the input potential, but since the reference potential which is derived from the source also changes by about the same source also changes by about the same amount, the input and output of the detector remains much as it was, and no manual adjustment of the circuit is necessary.

Initially, no trigger circuit was used and the rotor-tip component was amplified until it was sufficient to drive a transistor to saturation. This system worked well at water flow of 20 cm per second and upwards, but at lower flow rates the noise in the signal tended to give a false high count. The circuit shown here requires the same current (of opposite polarity) to turn it on and off, and successfully distinguishes rotor-tip signal from noise.

Originally, germanium diodes were used in the diode-pump circuit but calibration of the instrument then depended on ambient temperature. The diodes were changed to silicon and the change in calibration from 4 C to 40 C is then about equal to the uncertainty of calibration and can be neglected. A typical calibration is shown in Fig. 2. The photograph shows the instrument in use. The case is 7-in. long, 5-in. wide and 3-in. deep and weighs (complete with battery) 2½ lb. The battery consumption is less than 5 ma at 9 v.

The authors thank the Civil Engineering Department for making the measuring head and providing facilities for its calibration. The Armstrong Whitworth Equipment Company proposes to manufacture the instrument.

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(2) M. J. Wilkie, *J. Sci. Inst.*, 32, p. 350, 1955.

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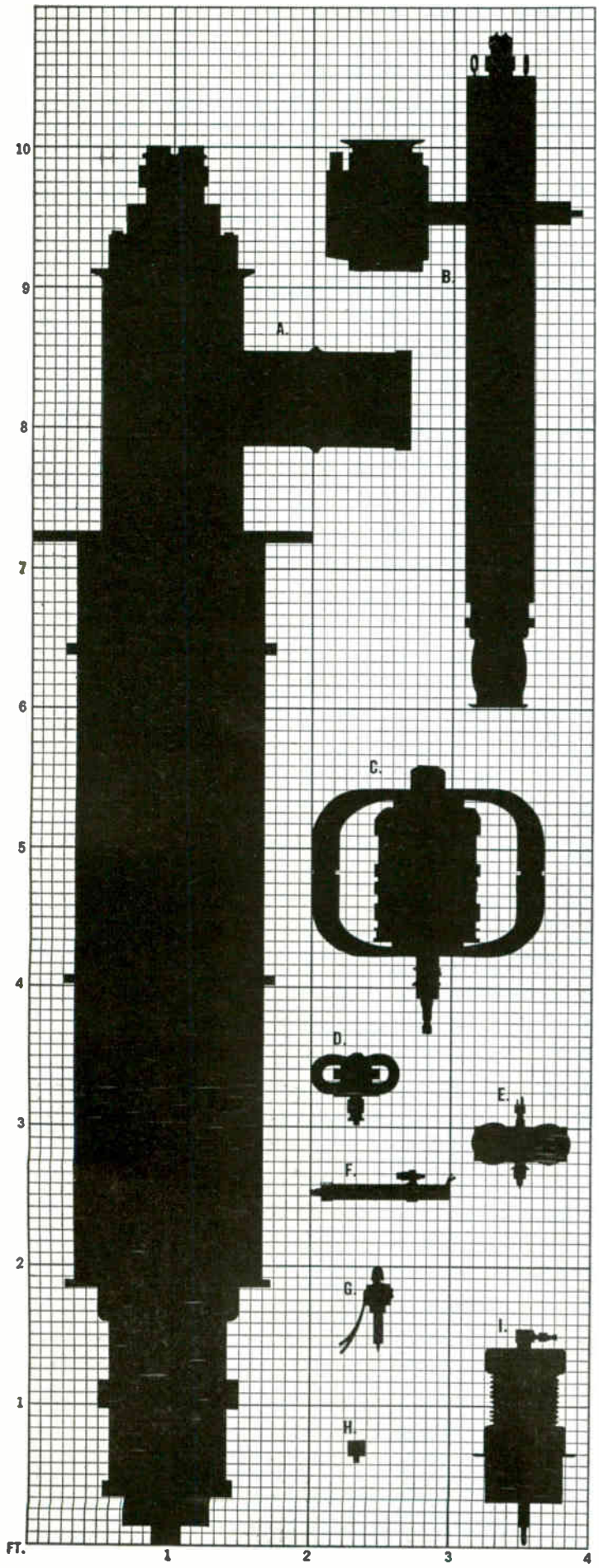

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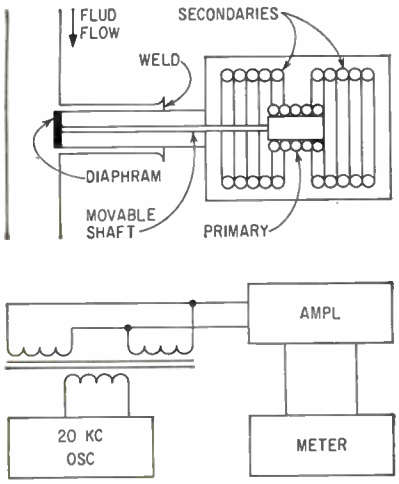


Secondary voltages cancel at zero pressure but at higher pressures the amplified difference is fed to calibrated meter

PRESSURE-MEASURING system has been developed for military and industrial applications in which difficult environmental problems must be overcome. The miniaturized pressure transducer in the system uses a differential transformer of special design that can operate at temperatures above 300 C. This light-weight transducer can be used in problem situations such as measuring pressures of liquid metals at elevated temperatures or gases in rocket engine combustion chambers.

The pressure-measuring system was developed by Precision Research, Inc., Stamford, Conn. A patent is pending on the transducer, according to E. L. Karlson, president of the firm.

The transducers will be available separately, as well as in systems, and cost is said to be moderate. The sensors will be produced in a variety of sizes covering pressure ranges from zero to as high as 5,000 psig. Solid-state components are used throughout the developmental pressure-measuring systems, which will be made to operate from either 28-volt d-c or 110-volt a-c power.

A simplified cross-sectional view of the transducer is shown in the figure with a block diagram of the system. The differential transformer used in the transducer has a movable primary that enables the transducer to sense diaphragm movements of less than 0.005 inch.

At zero pressure, the equal but oppositely phased voltages induced in the two secondary windings are cancelled. Increases in pressure displace the diaphram causing positive movement of the primary. The voltages induced in the secondaries are unbalanced, and the difference signal is amplified. The amplified output is fed to a suitably calibrated readout device.

Another basic objective in designing the transducer was to limit size so that it could be used in restricted spaces. The body of the transducer, which contains the differential transformer and provisions for temperature compensation, is 0.65 inch in diameter and 1.55 inches long. The specially designed movable primary windings have been made as small as $\frac{1}{16}$ inch in diameter. Ceramic insulation is used on the transformer windings to enable the transducers to withstand high temperatures.

Use of a higher frequency energizing voltage also contributes to the small size of the transducer. The 20-Kc drive oscillator in the diagram provides power to the primary winding at a voltage level suitable for the particular type transducer.

The sensing end of the type transducer shown in the figure has been reduced to 0.23 inch. This size sensor can be welded into a flanged well 0.25 inch in diameter. This arrangement brings the diaphragm in to the path of the fluid flow. Because there is no dead space in front of the diaphragm, no condensation problems can occur and response of the transducer is improved. The transducers will also be produced with the conventional arrangement of sensing element and diaphragm within the body.

The pressure-measuring system includes the drive oscillator, amplifier and meter, as well as the transducer. Output from the amplifier can be read out from a conventional analog meter or a digital voltmeter. It can also be recorded or used as an error signal in a control loop.

The transformer secondary voltages are easily balanced out at zero pressure. A single external mechanical adjustment controls the position of the secondary winding assembly relative to the primary.

The complete pressure-measuring system is small and is said to be relatively inexpensive.

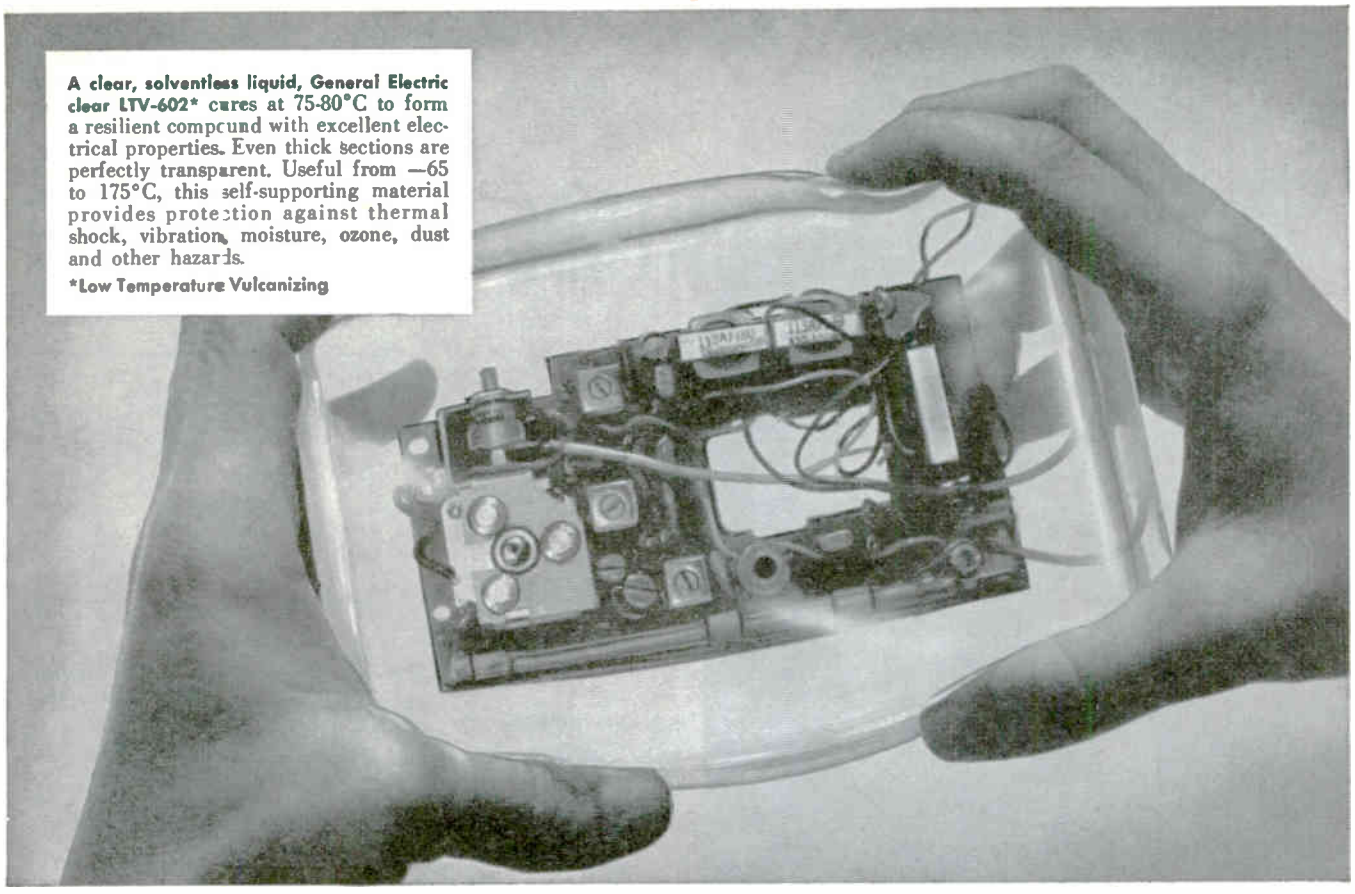
Battery Discharge and End-of-Life Indicator

By D. SHEVELENKO,
Wirecom Div., Cook Electric Co., Chicago, Ill

MAGNETIC amplifiers and semiconductors are combined in a battery-condition indicating system. The circuit was designed for aircraft, ground installations and critical communications systems in which nickel-cadmium batteries are used to provide emergency or auxiliary d-c power. However, the system can be modified for silver-zinc or other types of batteries.

The battery-monitoring system indicates when battery power is being used, when the battery is nearing exhaustion and finally when useful battery life is completed. Operation is based on the discharge curve in Fig. 1. Battery voltage drops slowly until a knee in the curve is reached at about 22.2 $\pm$0.1 volts. Battery voltage drops rapidly after passing the knee with the 18-volt level indicating the end of useful life.

When discharge current exceeds 0.25 ampere, the discharge lamp lights in the system shown in the block diagram in Fig. 2. When battery voltage has dropped to 22.2 volts, the end-of-life lamp flashes on and off. Finally, when battery voltage has dropped to the 18-volt

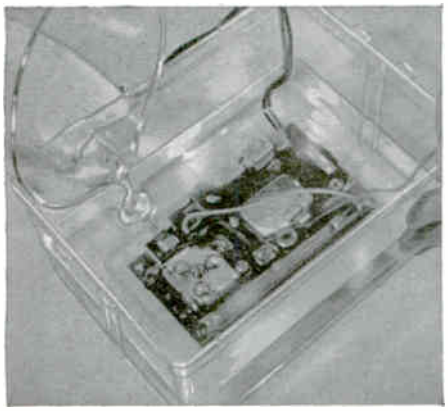


A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from —65 to 175°C, this self-supporting material provides protection against thermal shock, vibration,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

*Low Temperature Vulcanizing

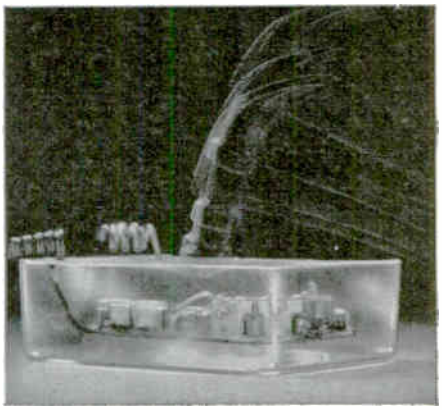
General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair



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

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



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

LTV-602 is the newest addition to the bread line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section N640, Waterford, New York.

GENERAL ELECTRIC

level, the end-of-life lamp remains lighted continuously. The sensing points can be changed for other types of batteries.

The control winding of the miniature magnetic amplifier used to sense discharge current consists of a low-resistance (about 0.01 ohm) stud that acts as a one-turn winding. It is connected is series with the battery. When discharge current flows, the amplifier switches on the discharge lamp through the transistor gate network.

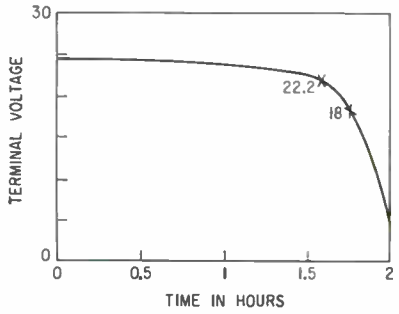


FIG. 1—Discharge curve for nickel-cadmium battery shows knee after which voltage drops rapidly

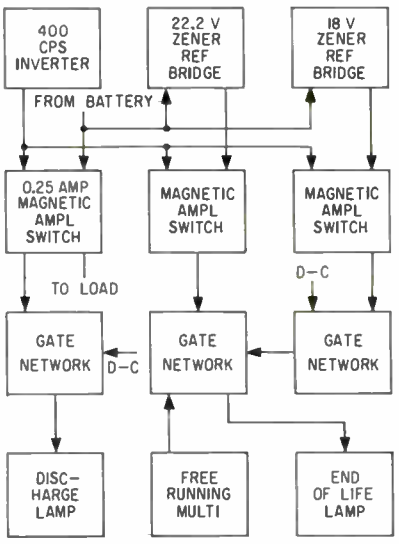


FIG. 2—Zener bridges sense battery voltage levels to indicate condition

For a reasonably good appraisal of battery condition, battery voltage must be sensed within 0.5 percent. Accurate voltage sensing is accomplished using a highly sensitive Zener diode bridge in conjunction with a miniature magnetic amplifier for each of the two voltage levels. A large amount of positive feedback is used in the amplifiers to provide regenerative switching at the sensing points.

The sensing circuit is electrically isolated from the rest of the system by the magnetic amplifiers. When battery voltage has dropped to the 22.2-volt level, a free-running multivibrator switches the end-of-life lamp on and off through a transistor gate network. At the 18-volt level, the end-of-life lamp is switched on continuously. The 400-cps inverter provides excitation to the magnetic amplifiers. The complete package, which weighs less than 3¾ pounds, meets the requirements of specification MIL-E-5272.

Ultrasonics Analyzes Milk and Other Liquids

PROPAGATION velocity of ultrasonic waves in milk may provide a new standard for evaluating its nutritional content. An instrument has been developed after ten years of effort that uses this approach to determine percentage of solids-nonfat content of milk. Proteins and minerals—the solids-nonfat content of milk—is accepted as a better gage of nutritional value.

The analyzing instrument, which can be used to determine properties of other liquids, was developed by Chesapeake Instrument Corp. It requires only a few minutes to make an analysis that sometimes rakes more than three hours using conventional chemical methods.

Although the relationship between solids-nonfat content and nutritional value has been recognized, a convenient method was required to measure this characteristic. For the past 70 years, Babcock tests have been used, which are performed by chemists and require complex equipment.

The new instrument converts ultrasonic propagation velocity into percentages of butter-fat and solids-nonfat content, indicating them on two dials. The analyzer, which is said to be highly accurate, can be operated by personnel without professional skills. After switching it on and setting controls, a sample cup containing the milk is plugged into the instrument.

The tester is expected to be incorporated into a continuously controlled milk processing system. The development could result in establishing milk prices on a recognized criterion of nutritional value.

Leslie K. Gulton runs his company as an engineering university whose purpose is profit. Eyeing the future, he teamed up with Glenn (Glennite) Howatt to create new markets for components. Ingredients for his success: take an intuitive sense for science, a knowledge of how to run a business, and a tremendous drive. Mix well daily

Extending the Scope of Ceramics

LAST WEEK, in an interview with Leslie K. Gulton, head of Gulton Industries, Inc., Metuchen, N. J. this column learned that a breakthrough in the state of transducer art at his firm has produced a superior ceramic piezoelectric material that will extend dimensions in industrial processing, remote control, anti-submarine warfare, ultrasonics, medical electronics, and fuzing and fuze devices. This is news for the doctor, designer and satellite maker.

Called Glennite HT (a lead zirconate titanate), this material has a dielectric constant of 1,800; a coupling coefficient that is between 65 and 70 percent; a charge-to-force ratio (d31) of -170×10^{-12} coulombs/newton; and a sensitivity of -11×10^{-3} volt-meters/newton.

Along with these characteristics, the new ceramic has a density approaching the theoretical x-ray density of 8.1 gm/cc.

These characteristics are tabulated from results obtained at Gulton's Materials and Standards Testing Laboratory, and from other standards engineers who have appraised the new material for specific applications.

The improved ceramic is being incorporated in transducers for antisubmarine warfare applications, in configurations which offer a greatly increased range of operation both for transmission and reception of information under water. The ceramic can be used at depths far exceeding present requirements, for example at depths below 5,000 feet. This interests oceanographers who plan to plumb the sea in the near future.

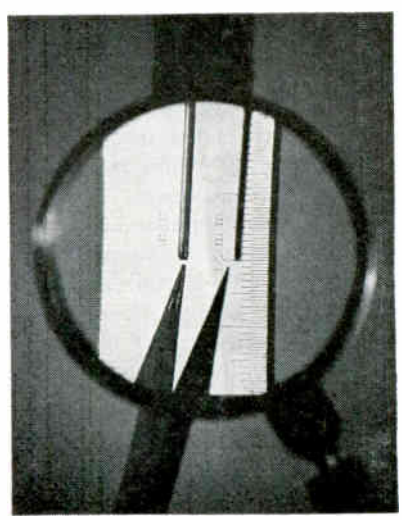
At Gulton, these new transducers will be incorporated in complete systems concerned with underwater sound studies. The company's background in ceramics, plus its capability in instrumentation and data handling techniques, provide a basis to manage complete systems work which will capitalize on this new material.

A leading chemical company in Maryland is using the ceramic in a new application involving dust precipitation devices for industry. Improved devices are planned to tackle smog and smoke problems which plague industrial plants located in metropolitan centers. High powered ceramic cylinders up to six inches in diameter and one foot long are used for this work.

Transducers using this new material comes in sizes from fractions of an inch, up to 24 × 24 in.

In heat exchangers, these transducers have enough power to shake loose actual solid deposits from tanks, improving heat-exchange characteristics.

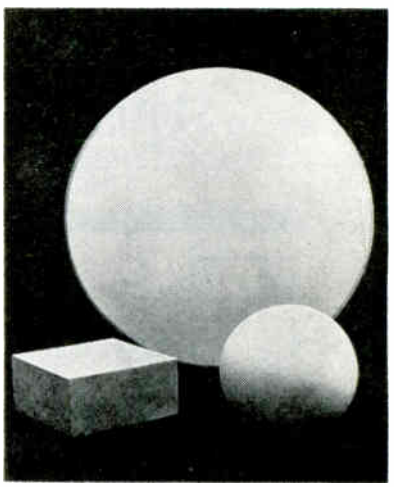
The greater sensitivity of the material will enable scientists and



Pencil points to tiny transducer element, mounted on the end of the wire rod. This unit is used to measure shock waves at a leading nuclear research laboratory. The unit measures 0.060-in. in diameter by 0.020-in. thick

engineers to obtain more exact measurements of shock waves. Heretofore, the physical size of the transducers used interfered with the phenomena measured. For in contrast to the large transducers, subminiature units will be used for shock wave tests, and in medicine.

For example, a medical college on the East coast is using the new ceramic for shattering kidney stones, for removal without surgery. Although this approach is familiar to medical research (see ELECTRONICS, p 59, Feb. 24, 1961), improved tools perfect these techniques with greater success. The size of the probes and the proper ultrasonic energy transfer are important factors for success in this type of operation. Since the new ceramic can be incorporated into a smaller unit, it will help overcome size and energy transfer problems.

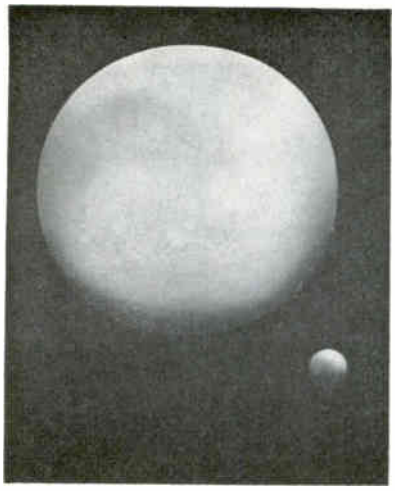


Ceramic transducers come in all sizes and shapes. These utilize new pressure-firing techniques that obtain greater sensitivity

In a cylindrical unit, the transducer element measures 0.045-in. in diameter, has a wall of 0.010 in., and a length of 0.062 in. Thus the old nostrum of "dissolving" kidney stones is accomplished by disintegration of the stones mechanically, through ultrasound.

Ceramic transducers 0.060-in. in diameter are being mounted on test equipment. At this size, flow patterns are not disrupted, and the sensitivity of these devices enables exact measurements of velocities and directions.

The shock wave front can be accurately plotted electronically rather than with smoke or dye tech-



Spherical transducers shown here are used to transmit and receive intelligence in underwater sound applications

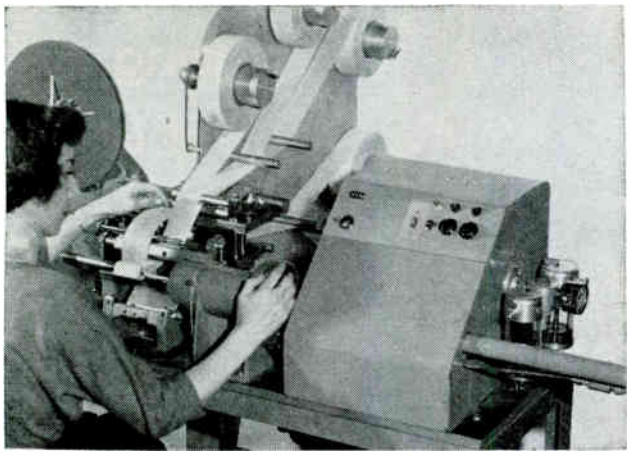
niques. This is important to missile makers, who must run aerodynamic wind tunnel tests before actual launchings are possible.

In fuzing applications, a new measure of safety is incorporated. Because of the high output of the ceramic, the actual detonators can be made less sensitive, thus reducing the possibility of premature detonation of warheads. Organizations like Sandia, using ceramics in fuzing applications, are now taking advantage of the improved characteristics.

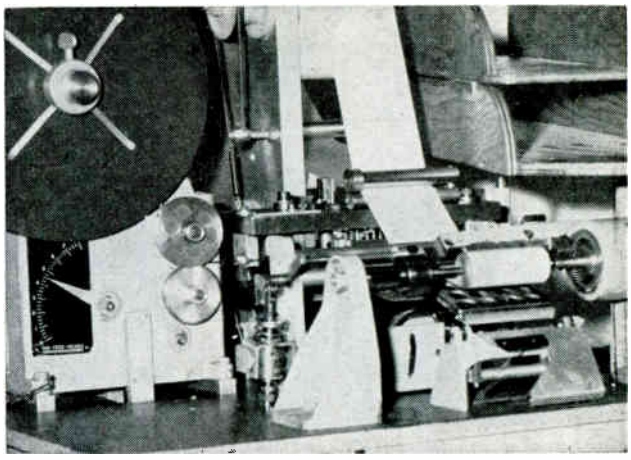
The Glennite high temperature material that was supplied previously, with a dielectric constant of 1,350; a lower charge-to-force ratio of -132×10^{-12} coulombs/newton; and a coupling coefficient of 52 percent will be continued in production. This ceramic will be used in applications that previously used the non-lead zirconates. The lower cost advantage of the non-leads will hardly offset the desirable properties of Glennite lead zirconate-titanate.

At Gulton, engineers are talking of ceramics with dielectric constants of over 2,000. These values put them beyond capacitor materials. This lies in the future, but as Gulton says, "The future has a way of becoming the present".

One of the factors responsible for the breakthrough has been technological advances in pressure-firing ceramics which eliminate the problem of voids, or greatly minimize their importance in the makeup of ceramic transducers.



Operator positions anode foil in winding



Closeup of mechanism in winding position

Capacitor Winder Tabs Automatically

WINDING MACHINE recently developed for the production of aluminum foil electrolytic capacitors automatically feeds and stakes cathode tabs, loads the winding arbor, swages the cathode foil and cuts off the completed capacitor.

Typical production rates reported by Wellington Electronics, Inc., Englewood, N. J., are 800 per hour for single-section, seven-inch-long anode capacitors with four papers, and 200 per hour for quad-section capacitors, anodes 74 inches long, with six papers. Capacitors can range up to 2.25 inches in diameter and papers, from one to four inches wide. Tabs can extend 1.5 to four inches. All setups can be made by the operator.

Tabs are staked to the cathode foil by a progressive die. The staking method—piercing the foil at several locations, lifting circular segments, pressing and compressing the tab into the foil—is reported to give a contact resistance of only 0.0001 ohm. The tab is fed from a reel in the setup length.

This operation is performed as the capacitor previously wound is being cut off. The tab is automatically placed nine inches from the beginning of the winding. If another tabbing length is desired, the operator can switch off pressure to the air-actuated die and switch it back on at the desired position.

The foil then passes on to a pickup platen, where it is merged between the papers. A friction-coated roller with a one-way slip clutch, at the back end of the platen, maintains tension on the web during winding. The paper and foil supply rolls are individually tensioned by springs which the operator can adjust by thumb screws at the front of the machine. This type of tensioning permits paper rolls to be 11 inches in diameter.

The air-operated platen, which was depressed during the winding of the previous capacitor, lifts the end of the web into line with the arbor. The halves of the split arbor, which were retracted into the winding chuck, pass on either side of the web and lock in the spindle.

The operator inches the arbor around 1.5 turns, then inserts one or more anode foils. The arbor drive motor can be inched or operated at speeds up to 900 rpm by a sewing-machine type foot pedal.

When the anodes are fully wound, the operator trips an air-operated cut off bar. The bar rotates down behind the arbor to press the web against a sawtooth knife on the forward edge of the platen. The knife leaves the remaining few turns of the capacitor attached by a few strands to the web.

At the same time, the operator lifts the end of a roll of cellulose adhesive tape placed below the arbor. The end is pressed onto the capacitor. As the winding motor is reengaged, the tape presses against another sawtooth knife a few inches from the arbor. The knives part the web and tape and the last few turns are wound and taped. The arbor retracts, dropping the capacitor into a chute. The cut off bar carries a swaging tool which can be set to press against the exposed edge of the cathode foil.

A trip switch enables the operator to interrupt the cycle any time there is a winding error. The arbor frees the faulty capacitor and the machine returns to loading position. Good capacitors are counted as they roll down the chute. The counter will only operate if the machine has completely cycled.

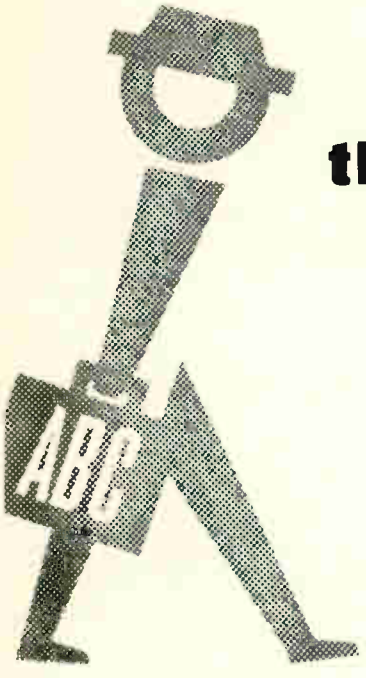
Anodes are staked and cut to length in advance. Wellington has devised a double-decker feed tray which keeps 800 anodes, in four lengths, at the loading position.

Old Umbrella Rib Is Quick Cable Pigtailer

UMBRELLA RIBS make handy tools for pigtailing braided-shield cable. Electronic Associates, Inc., Long Branch, N. J., takes about three inches of rib with hollow, semicircular cross-section, files one end to

here,

there . . .



almost everywhere

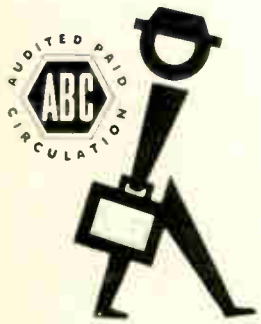
Members of the specially trained, 70-man field auditing staff of the Audit Bureau of Circulations* make regular calls on 2,900 publications . . . ours included . . . located in almost as many places.

The ABC auditor's call might last a day, a week, or even several months . . . just as long as it takes him to make a complete audit of our circulation records and obtain the information about our circulation audience that ABC will later publish.

Actually, he is working for you — our readers and our advertisers. Knowing full well that we will stay in business only so long as our publication continues to serve the interests of our readers, this audit of our *paid* circulation provides us with a regular and objective review of how well you think we are doing.

Knowing full well that sales messages must reach a responsive audience in order to be effective, our advertisers are also interested in the ABC auditor's call. The hard, and sometimes cold, facts he reports about our circulation provide you with an informed basis for investing your advertising money.

Yes, the ABC auditor has been here . . . and he will be here again, calling to check on how well we are doing our job and to provide the facts to help us *and our advertisers* do even better.



electronics

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a point and fixes the other end in a wooden handle.

After outer insulation has been stripped from the end of the cable, the operator pushes up the braid until a bump forms about an inch from the end. The rib is slipped over the inner dielectric and pushed up under the braid until the point of the rib is at the bump.

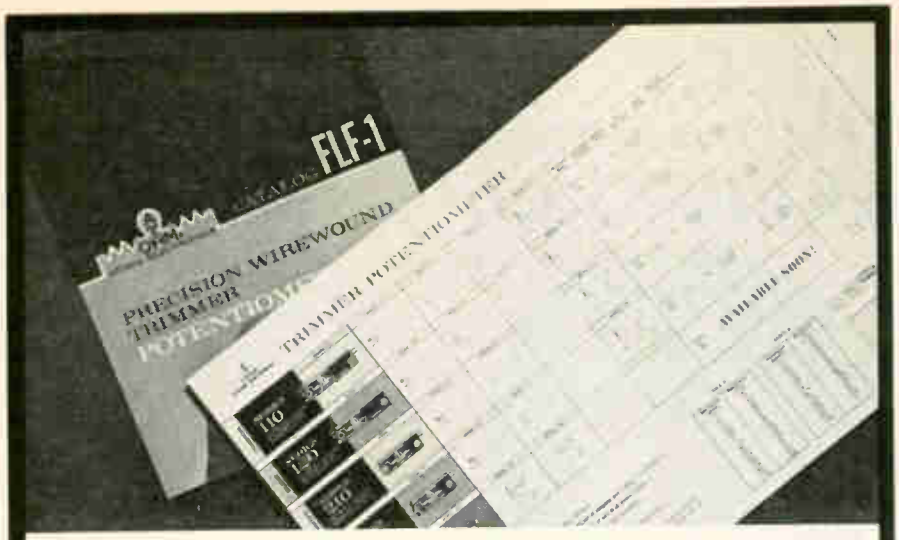
Braid is pushed up to form a lump

Tool pushes inner cable through braid

Inner cable is pulled out of braid

Round side of rib smooths out braid

The point is worked through the braid until there is an opening large enough for the inner dielectric and conductor. The rib is pushed through until the handle of the tool pushes the inner dielectric and conductor through the opening in the braid, forming a loop. The rib is withdrawn, inserted in the loop and the inner



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cable pulled free.

For some sizes of cable, EAI has found this method considerably faster than the hypodermic needle type of pigtailer (ELECTRONICS, p 98, July 31, 1959).

Fluxing with Glycol, Soldering Magnesium

POLYETHYLENE GLYCOL is again recommended as a solvent for solder fluxes, in the latest issue (No. 51) of the Tin Research Institute *Journal*.

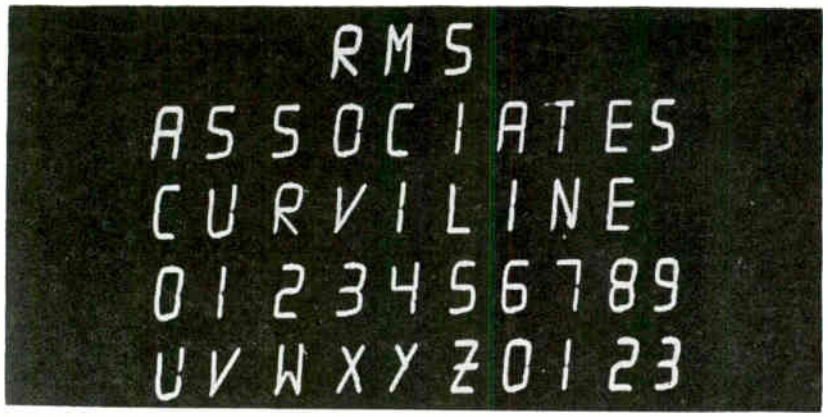
The previous report (*Journal* No. 46 and ELECTRONICS, p 96, July 31, 1959) emphasized that rosin flux dissolved in glycol presents no fire or fume hazard. The new report points out that since the glycol does not evaporate at soldering temperatures, glycol-based flux spreads evenly and does not form a dry resin film that must be melted by the solder. However, the Institute cautions, residues are hygroscopic and may affect electrical resistance. Residues can be removed by water.

The Institute also recommends glycol instead of water as a solvent for acid fluxes (not normally used by electronics manufacturers). The nonevaporating solvent facilitates the spread of solder and helps prevent corrosion. The film covering the metal retards oxidation, the acid does not spatter, much less flux is required, the residues are instantly soluble in cold water and can be quickly removed.

Another report describes how to prepare magnesium for soldering. Bare magnesium cannot be soldered directly, due to oxide formation, nor copper-plated, due to chemical reaction. The recommended method (credited to Brooks & Perkins, Inc.) is to form a zinc undercoat by dipping the magnesium in a sodium zincate solution, copper-plate 0.0002 or 0.0003 inch in an ordinary cyanide bath, or nickel-plate, then electroplate with tin 0.0002 inch and flow-melt the tin to bond it to the copper. The tin remains solderable for a long time under ordinary conditions.

The Journal and other reports are available in the United States from the Institute's office at 492 West Sixth Avenue, Columbus 1, Ohio.

New On The Market

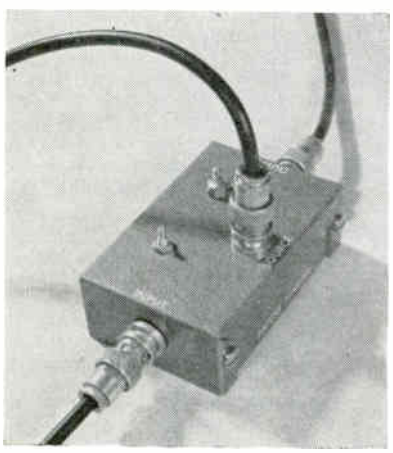


Character Generator
STRAIGHT AND CURVED LINES

SOLID-STATE character generator, called the Curviline, has been developed by RMS Associates, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.

Straight and curved lines are used to form digits, letters and symbols. Writing rates to 50,000 characters per second are obtained by forming all symbols from simple formats. Curved lines prevent confusion between similar letters and digits. Series C36000 is packaged in a 4 × 6 × 7 inch cabinet; series CL36000 is packaged on a standard 5¼ inch relay rack panel. In prototype quantities, prices range from $4,000 to $4,500; delivery in 30 to 60 days. Readout is by crt and power consumption is 5 watts.

CIRCLE 301 ON READER SERVICE CARD



Solid-State Amplifier
HIGH IMPEDANCE

SOLID STATE amplifier has input impedance of 15,000 megohms shunted by 1 to 1.5 pf (plus shunt capacitance of input BNC connector of 1 to 2 pf); output impedance is 1 megohm shunted by 3 to 10 pf. Frequency response is 3 cps to 300 Kc (± 3 db), or 5 cps to 100 Kc (± 1 db).

Voltage gain varies from 0.2 to 0.5, depending on impedance levels of input and output, and power gain is 30 to 35 db. Noise at output with input open is 50 to 100 microvolts; power required is 30 mw. Prototypes are available at $87 each from Denco Labs, 2801 15th St., N. W., Washington 9, D. C., with delivery in 2 to 3 weeks.

CIRCLE 302 ON READER SERVICE CARD

Network Analog
SOLVES EQUATIONS

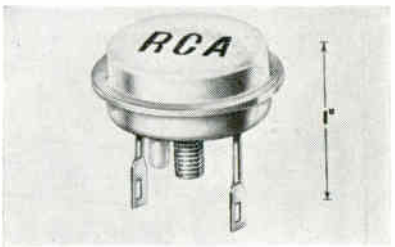
PRECISION RESISTANCE network analog quickly solves problems involving Poisson's, Laplace's and special cases of Maxwell's equations. Overall network accuracy is better than one part in 10,000. Examples of problem solutions include determination of fields, studies of electron-optics, ion-optics, electric current flow in liquids and solids, heat flow under steady-state conditions, aerodynamics, hydrodynamics, and elasticity.

The network analog contains 150 current injection sources, may be combined with a digital computer for some problems. Problems such as the calculation of the spherical aberration in an electron lens may now be solved easily. Prices and delivery are available from Litton Industries, Research Laboratory, 960 Industrial Rd., San Carlos, Calif.

CIRCLE 303 ON READER SERVICE CARD

Power Transistor
SILICON; 150 WATTS

SILICON POWER transistors RCA-2N2015 and 2N2016 are 150-watt silicon *npn* units having low saturation resistance (0.25 ohm max), high betas (7.5 min. at I_c = 10 amp, 15 to 50 at I_c = 5 amp), and operating temperature range of −65 to +200 C.



The transistors, in JEDEC TO-36 package, can be used in such applications as switching for converters, choppers and relay control equipment; oscillators, regulators, pulse-amplifiers; and audio and servo amplifiers. Manufacturer is RCA, Semiconductor and Materials div., Somerville, N. J.

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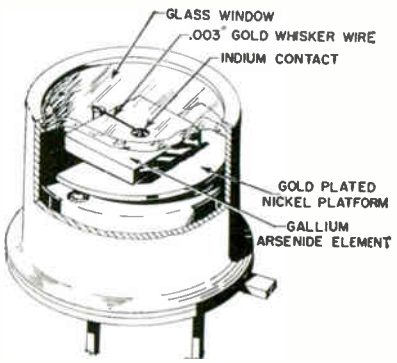
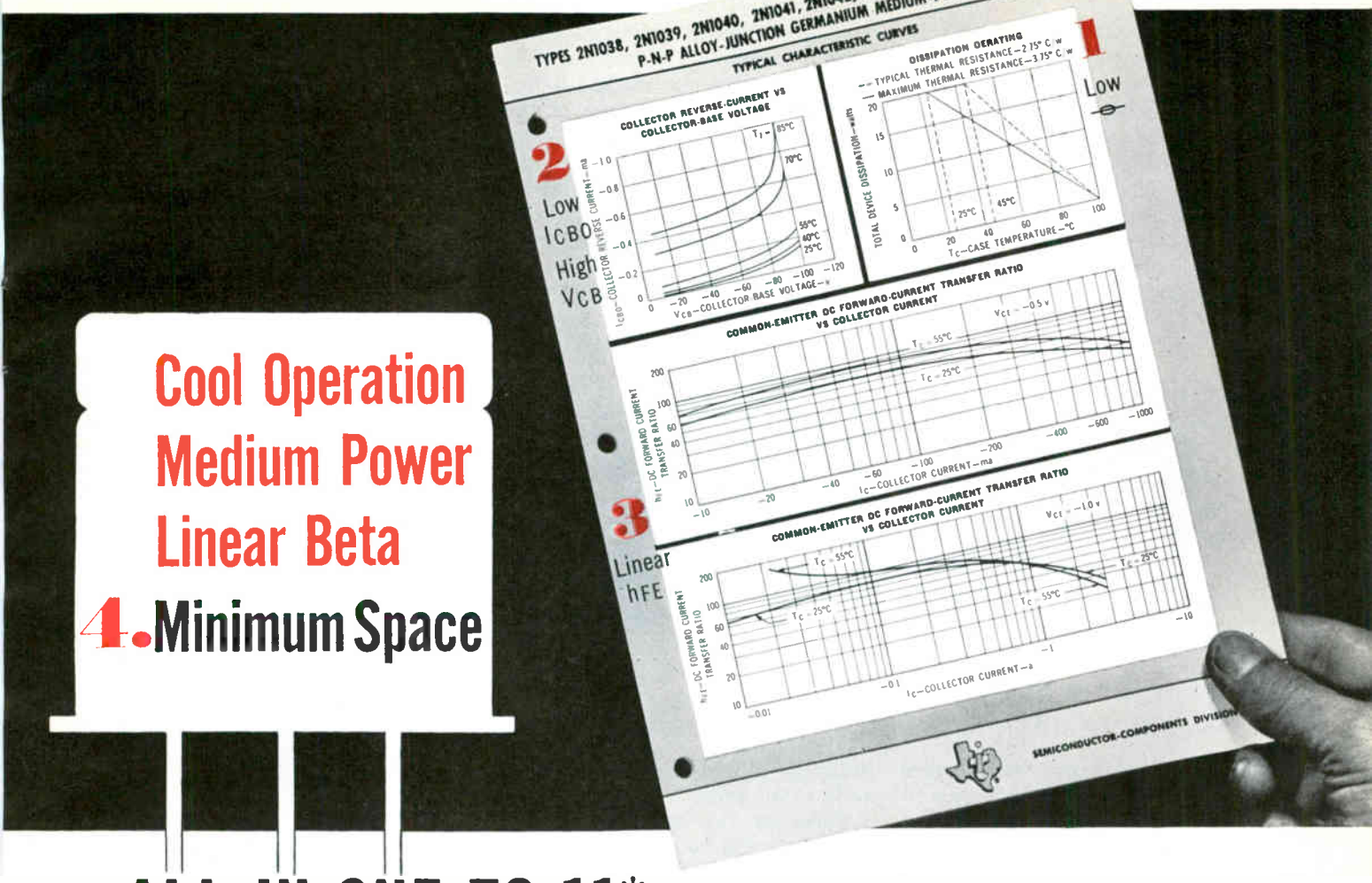


Photovoltaic Detector
0.4 TO 0.9 MICRON RANGE

GALLIUM ARSENIDE photovoltaic detector in a TO-18 case is designed for the 0.4 to 0.9 micron region, with peak sensitivity at 0.85 micron. The device provides greater

CIRCLE 81 ON READER SERVICE CARD →



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Three packages for your design assistance—at no extra cost

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I_C	1 amp	1 amp	1 amp	1 amp	3 amp	3 amp	3 amp	3 amp
BV_{CBO}	40	60	80	100	40	60	80	100

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sensitivity than multiplier phototubes and silicon photodiodes. The detector does not suffer serious sensitivity degradation when exposed to daylight, and can be operated up to 120 C without loss in sensitivity. Optimum characteristics are observed at room temperature. Applications include: celestial body sensing, missile tracking, fuzing and warning, space vehicle and satellite attitude control and guidance, stellar supervision of inertial platform, computer readout and industrial process control. Price of the GAU-401 detector is $100 for sample quantities; delivery can be made in 1 to 14 days, depending on cell area desired. Manufacturer is Philco, Lansdale div., Lansdale, Pa.

CIRCLE 305 ON READER SERVICE CARD

Log Frequency Converter

3-DECADE RANGE

LOG FREQUENCY converter provides a d-c voltage output that varies in proportion to the logarithm of the frequency of the input signal. Input may vary from 0.5 volt to 100 volts and may have high harmonic content without affecting accuracy. The converter is used in combination with X-Y plotters to provide the log frequency signal for the X axis. Full scale outputs are 100 millivolts at 400 ohms or 10 millivolts at 40 ohms.

Price of the Model HLFC120 converter with 20 cps to 20 Kc discriminator plug-in, and 10 Kc plug-in oscillator, is $565. Additional discriminator plug-ins are $150. Delivery is 45 days; manufacturer is Houston Instrument Corp., P. O. Box 22234, Houston 27, Tex.

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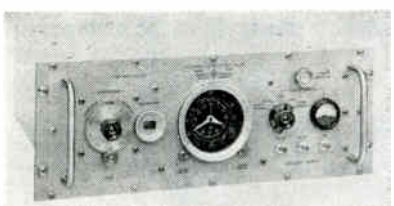


Frequency Divider & Clock

H-F AND VLF STANDARDS

FREQUENCY divider and clock provides highly precise comparisons between local time or frequency standards and h-f or vlf broadcasts. Drift rates can be recorded over long periods, and time or frequency differences can be determined between oscillators in widely separated systems. Model 113BR also generates precise, adjustable time signals whose accuracy is limited only by that of the driving oscillator. Overall accuracy is ± 10 microseconds. The instrument uses transistors, meets all performance requirements of MIL-E-16400, and is suited to mobile operations. Price is $2,750, delivery time is 3 weeks, from Hewlett-Packard Co., 1501 Page Mill Rd, Palo Alto, Calif.

CIRCLE 307 ON READER SERVICE CARD

Magnetic Field Probe

A-C FIELDS

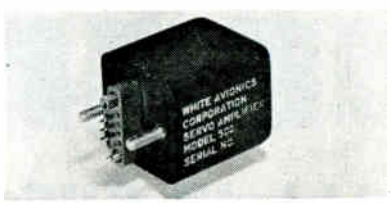
MAGNETIC field probes, individually assembled and calibrated to operate with a vtvm, determine a-c magnetic field intensity. Each unit is calibrated in a known field and rms voltage output is given as a function of gauss level. Probe consists of an air-core inductor epoxy cast within an electrostatic shield enclosure. Pick-up circuit terminates at 100,000 ohms. Available from stock, at $15 each, from Magnetic Shield div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 308 ON READER SERVICE CARD

Servo Amplifier

SOLID-STATE

WHITE AVIONICS CORP., Terminal Road, Plainview, L. I., N. Y. Model 500 servo amplifier drives a center tapped size 11 servo motor. Gain is 2,500; stability, ± 3 db from − 65 C to + 125 C, ± 2 db from − 35 C to + 125 C; input impedances of 10,000 ohms to ½ megohm available; life in excess of 1,000 hr; size, 1 by 1 by 1⅜ max. It is designed for airborne requirements.



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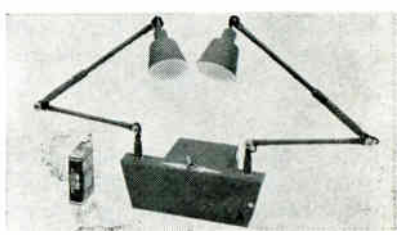
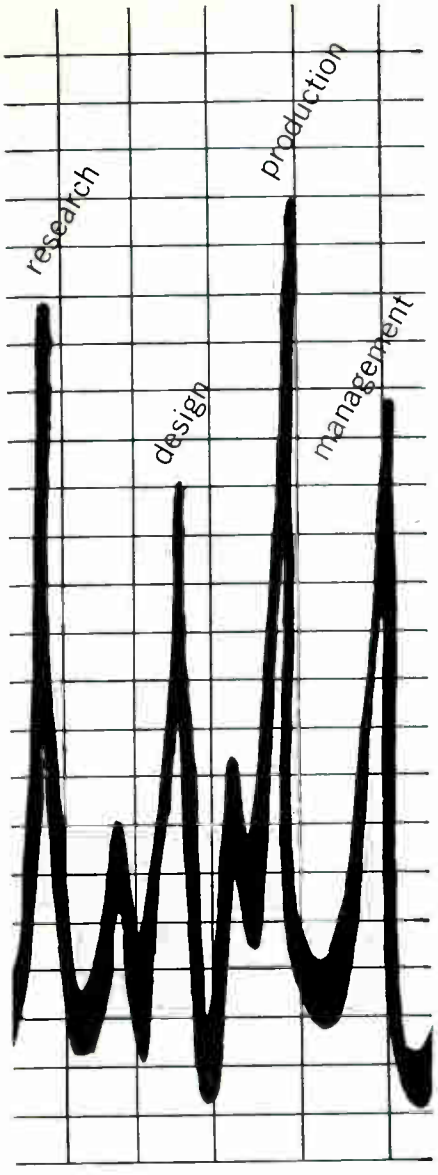


Stereo Work Lamp

GLARE-FREE

TENSOR ELECTRIC DEVELOPMENT CO., INC., 1873 Eastern Parkway, Brooklyn, N. Y. Designed for glare-free, shadowless, concentrated lighting, model 5917 is useful in small, precision assembly and inspection. Each lamp arm has three joints and connects to the base by means of a phone plug, enabling 360 deg rotation. A 2-stage switch on the base provides for high and low levels of lighting. At a working distance of



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CIRCLE 310 ON READER SERVICE CARD

Delay Lines

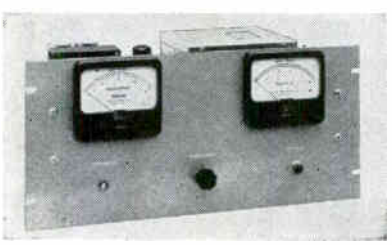
ANDERSEN LABORATORIES, 501 New Park Ave., West Hartford 10, Conn. Series of lumped-constant electromagnetic delay lines, feature a density of 60-70 delay sections per cubic in.

CIRCLE 311 ON READER SERVICE CARD

Audio Programmer
COMPACT UNIT

TECNI-ART ENGINEERING, P.O. Box 96, Glendale 5, Calif. The Rel-A-Tron programmer, with separate sound and inaudible signal channels, actuates relays automatically. It is basically a compact tape recorder with an electronic timing unit that enables it to operate cycled motion type equipment such as slide projectors, animated displays, and the like, with or without sound. User can change cycling signals at the push of a button.

CIRCLE 312 ON READER SERVICE CARD



D-C Power Supply
R-F TYPE

SPELLMAN HIGH VOLTAGE CO., INC., 1930 Adee Ave., Bronx 69, N. Y. Model LAB-10 is continuously variable from 0-15 Kv. Regulation across entire range better than 1

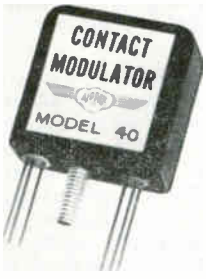
percent. D-C current output 2 ma. Available either positive polarity output or negative. Automatic overload and sensitivity control available at $50 additional. Price is $275 net.

CIRCLE 313 ON READER SERVICE CARD

Meter-Relays
TAUT BAND MOVEMENT

ASSEMBLY PRODUCTS, INC., Chesterland, O. Meter-relays with a taut band movement offer high accuracy and repeatability in ranges of 50 μa or less. Because of the elimination of friction they are suitable for control applications requiring full-scale sensitivities in the area of 0 to 5 μa or 0 to 2 mv.

CIRCLE 314 ON READER SERVICE CARD



Midget Chopper
LOW NOISE

AIRPAX ELECTRONICS INC., Cambridge, Md. Model 40 chopper, designed for 400 cps drive, withstands 100 g shock and vibration in any direction equivalent to sinusoidal vibration at an amplitude of 0.060 in. total travel over a frequency of 10 to 55 cps and 15 g from 55 to 2,500 cps. At 1 megohm load, 400 cps, noise is down in the random noise level. Unit is hermetically sealed and a continuous operation is maintained over a range of -65 C to $+100$ C.

CIRCLE 315 ON READER SERVICE CARD

Picoammeter

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Response speed is from one millisecond to 64 percent of final value at 10^{-9} to 10^{-3} amperes with external circuit capacity up to 2,000 picofarads. Zero drift is less than 0.25 percent of full scale.

CIRCLE 316 ON READER SERVICE CARD

Literature of the Week

TV-STUDIO TEST UNITS Tektronix, Inc., P.O. Box 500, Beaverton, Ore. A 16-page booklet describes three instruments for maintenance and adjustment of tv transmitter and studio equipment.
CIRCLE 317 ON READER SERVICE CARD

COAXIAL ISOLATORS E&M Laboratories, 15145 Califa St., Van Nuys, Calif. An illustrated bulletin covers the L-band coaxial isolators that have an overall length of 6.45 in.
CIRCLE 318 ON READER SERVICE CARD

SERVO AMPLIFIERS Melcor Electronics Corp., 48 Toledo St., So. Farmingdale, L. I., N. Y. Bulletin 1030-4-61 covers 400 cps transistorized power amplifiers designed to drive 40 v two phase servomotors of up to 14 w input per phase.
CIRCLE 319 ON READER SERVICE CARD

RELAY Filtors, Inc., 30 Sagamore Hill Drive, Port Washington, N. Y. A 12-page brochure describes the company facilities by telling the story of how its premium quality relay, the Golden G, was conceived and how it is made.
CIRCLE 320 ON READER SERVICE CARD

MARINE ALTERNATOR The Leece-Neville Co., 1374 E. 51st St., Cleveland 3, O. Brochure describes typical applications, construction details and specifications of 6, 12, 24 and 32-v alternator systems for marine applications.
CIRCLE 321 ON READER SERVICE CARD

FAST-POLISHING OXIDE Vitro Chemical Co., 342 Madison Ave., New York 17, N. Y., has issued a brochure describing Vitrox C, its fast-acting glass-polishing oxide, and a special family of anti-foaming reagents developed for use with it.
CIRCLE 322 ON READER SERVICE CARD

PLANAR PROCESS Fairchild Semiconductor Corp., 545 Whisman Road, Mountain View, Calif. Brochure describes the technology of the planar process whereby semiconductor devices have as their ma-

jor feature a surface junction protective oxide.

CIRCLE 323 ON READER SERVICE CARD

P-C TECHNIQUE Intellux, Inc., P. O. Box 929, Santa Barbara, Calif., has prepared literature detailing how multilayer circuitry can accurately reproduce the most sophisticated patterns.

CIRCLE 324 ON READER SERVICE CARD

POWER SUPPLIES Quan-Tech Laboratories, Inc., Boonton, N. J. A technical flyer describes three versions of the series 170 modular, solid state, regulated power supplies.

CIRCLE 325 ON READER SERVICE CARD

ATTENUATOR SET Weinschel Engineering Co., 10503 Metropolitan Ave., Kensington, Md., announces a specification sheet on model AS-1 precision attenuator set for use in standards laboratories.

CIRCLE 326 ON READER SERVICE CARD

MEMORY TESTER Digital Equipment Corp., Maynard, Mass. Type 2201 Memory Exerciser, a test facility for the manufacturer and user of core memory systems, is described in a 4-page folder.

CIRCLE 327 ON READER SERVICE CARD

EPOXY MOLDING COMPOUNDS The Fiberite Corp., Winona, Minn. A reprint describing epoxy molding compounds includes a table comparing epoxy with six other molding compounds.

CIRCLE 328 ON READER SERVICE CARD

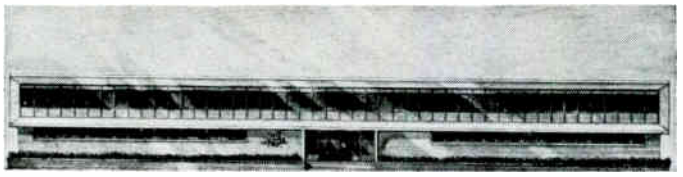
PLASTICS The Polymer Corp., Reading, Pa., announces a general products brochure on the properties and availabilities of Polypenco industrial plastics.

CIRCLE 329 ON READER SERVICE CARD

SILICONES General Electric Co., Waterford, N. Y. A 16-page brochure, entitled "Silicones for the Space Age", is now available.

CIRCLE 330 ON READER SERVICE CARD

FREQUENCY & TIME STANDARDS Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. *Application Note* No. 52 is a comprehensive manual of frequency and time standard systems. Copies may be obtained by writing directly to the company.



Aero Geo Astro Corp. Still Expanding

CONSTRUCTION is underway on a million-dollar plant for the Aero Geo Astro Corp., research and development firm, in Alexandria, Va.

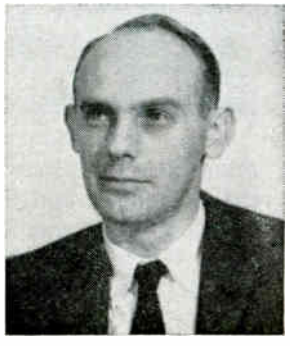
The firm, which was started in 1958 by two electronics experts, now has nearly 200 employees and six plants in Alexandria and two out-of-town facilities in Corona, Calif., and Fort Walton Beach, Fla.

The new Alexandria plant will be a two-story structure with a penthouse roof to be used for radar and antenna experiments. Total floor space of the structure will be more than 100,000 sq ft.

The concern has become known for its development and production of a tiny transponder now being used in American missile systems. In its research and development programs of reconnaissance, surveillance, guidance, communications and countermeasures, Aero Geo Astro has also developed a complete aircraft antenna system and a lightweight command receiver for missiles and satellites.

Some of the company's present work centers around an advanced radar program for the Navy and a long-range ballistic missile launching and nuclear explosion and detection system.

AGA's president is Kenneth S. Kelleher, who helped in the development of the first multiple beam radar antenna.



Ling-Temco Hires Gerald Hughes

GERALD E. HUGHES has joined the micromodular components division of Ling-Temco Electronics, Inc., Anaheim, Calif., as head of applications engineering. This division of Ling-Temco is engaged in the design, fabrication, and testing of highly compact miniature circuit modules.

Hughes was formerly with Rheem Semiconductor Corp. as a member of the technical staff for diode and rectifier applications.

New England Instrument Enters Microwave Field

NEW ENGLAND INSTRUMENTS CO., Waltham. Mass., manufacturer of both conductive plastic and wirewound precision potentiometers, has broadened its product line by entering into the microwave components field.

Capabilities of the microwave division under the direction of David Fulton range from design and development to manufacturing and complete electrical testing of both components and assemblies.

Electro-Tec Names Philip C. Ross

APPOINTMENT of Philip C. Ross to the newly created post of engineering manager of the switch devices section is announced by Electro-Tec Corp., South Hackensack, N. J., producer of precision slip ring assemblies and manufacturer of precision components for the electronics industry.

Ross comes to the Electro-Tec organization from the General Electric Co. where he was a lead product design engineer.

Amphenol-Borg Elects Feldmann

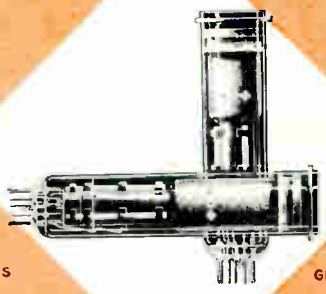
HENRY FELDMANN, president of FXR, Inc., Woodside, N. Y. manufacturer of microwave test instruments and equipment, has been elected to the board of directors of Amphenol-Borg Electronics Corp. following the merger of FXR and Amphenol-Borg. FXR becomes an Amphenol-Borg division with Feldmann continuing as its operating head.

Gallay to Direct ERA Division

HARRIS GALLAY has been named director of the newly formed microwave division of Electronic Research Associates, Cedar Grove, N. J. This division is developing and marketing a complete line of commercial microwave communications equipment for single hop and relay applications.

Gallay comes to ERA from the Curtiss Wright Electronics division

GEC INDUSTRIAL R. F. GENERATORS



GEC VIDICONS

GEC SCAN CONVERSION TUBES

GEC SCAN CONVERTERS

ADVANCED

ELECTRONIC DEVELOPMENTS FROM G E C

ELECTRONIC TUBES . . .

Vidicons with unsurpassed light sensitivity and low lag responding to all parts of the spectrum including near and far infrared.

FEATURES:

- 1 in. and larger sizes
- Electrostatic and magnetic focus and deflection
- Low power heaters
- Patented internal construction allows operation in any position

Scan Conversion Tubes provide controllable storage of input signal with simultaneous reading and writing.

GEC's Capability includes the design and development of a wide range of *pickup, conversion* and *display tubes.*

SCAN CONVERSION SYSTEMS . . .

Transistorized Scan Converters convert from any scanning format into another. One basic unit uses plug-in functional modules to provide required conversion. Modules presently available are: TV Control, PPI Control, and Slow Scan Control.

FEATURES:

- Translation of video information from one scanning mode to another
- Storage and Integration of video information
- Time-Coordinate Transformation providing expansion or reduction of bandwidth
- Rack-mounted requiring 36¾ in. of panel space
- Power consumption only 1.5 amp at 115 Vac, 60 cps
- No external power supplies are needed

GEC Monoscope Cameras, Radar Target Simulators and other system equipment are available for operating scan conversion systems.

INDUSTRIAL R. F. GENERATORS . . .

Induction and dielectric heating R. F. Generators are available in the very highest powers. GEC's extensive radio-frequency engineering is available to assist customers in special applications of R. F. Generators.

For additional information about your specific R & D needs, contact . . .

. . . . . advanced electronics at work

G E C

GENERAL ELECTRODYNAMICS CORPORATION

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where he was engaged in the development of a light-weight, high resolution, airborne Ka band radar system.

Oak Manufacturing Elects D. C. Smith

DIRECTORS of Oak Mfg. Co., Crystal Lake, Ill., component manufacturer, have elected Dean C. Smith, vice president, manufacturing.

Smith was formerly with Thor Power Tool Co. of Aurora, Ill., where he served in a similar position for the past 7 years.

United Components Forms Subsidiary

ORGANIZATION of a new subsidiary company, United Components, Inc. of New England, in Worcester, Mass., is announced by Rudolph A. Sachs, president of United Components, Inc., Orange, N.J.

The new company will expand the parent firm's lines in the semiconductor field, laying particular emphasis on the manufacture of controlled silicon rectifiers.

Gilson Advances To Division G-M

ROBERT J. GILSON has been appointed general manager of the military products division of General Dynamics/Electronics, Rochester, N. Y. He was formerly director of systems management for the division.

Tore Anderson Takes Top E.M.T. Posts

TORE N. ANDERSON was elected president and chairman of the board of E.M.T. Corp., Syosset, N.Y. Company specializes in flexible waveguides for the microwave industry.

Anderson, former president of FXR Inc., was vice president and director of engineering at Airtron, Inc. Division of Litton Industries for nearly 12 years.

PEOPLE IN BRIEF

Daniel J. O'Brien advances at Kaiser Aircraft & Electronics to plant manager of the west coast electronics lab. **Holman L. Anderson**, formerly with Convair Electronics, appointed manager of quality control at the San Diego branch of General Dynamics/Electronics' military products division. **Thomas R. Fahy** leaves Raytheon Co. to join Emerson Electric's acoustic research division as assistant to the scientific director. **George C. Gingrich**, ex-RCA, named to the technical staff of Auerbach Electronics Corp. **Truman H. Cline** transfers from Newark-Ohio Co. to Stevens Manufacturing Co. as manager of engineering. **Warren A. Christopherson**, senior engineer for IBM, named manager of a solid-state memory development group. **Ed Cook**, previously with Canoga Electronics, joins Technology Instrument Corp. as test equipment engineer. **Fred Hermann** chosen manager of Tenney Engineering's newly organized west coast division. **William T. Davis** moves up at Airco's cryogenic engineering dept. to supervisor of manufacturing engineering. **Paul S. Wells** promoted to general manager of Neptune Meter Co.'s electronic division. **Seymour Harrison** transfers from Budd Electronics to Trak Electronics Co. as engineering manager of the newly formed data processing engineering department.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

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

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

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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).

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AIRCRAFT ARMAMENTS INC. Cockeysville, Maryland	100*	2
CORNING ELECTRONIC COMPONENTS Corning Glass Works Bradford, Pa.	98*	3
ESQUIRE PERSONNEL Chicago, Illinois	93	4
GENERAL ELECTRIC Professional Placement Center New York, New York	100*	5
GRUMMAN AIRCRAFT ENGINEERING CORP. Bethpage, L. I., New York	92	6
LOCKHEED MISSILES & SPACE DIV. Sunnyvale, California	19*	7
MITRE CORPORATION Bedford, Mass.	98*	8
MONARCH PERSONNEL Chicago, Illinois	93	9
RADAR DESIGN CORP. Syracuse, New York	93	10
REMINGTON RAND UNIVAC Div. of Sperry Rand Corp. St. Paul, Minnesota	86	11
WLAC-TV INC. Nashville, Tennessee	93	12
WESTERN ELECTRIC Engineering Research Center Princeton, New Jersey	98*	13
P-6754	100*	14

* These advertisements appeared in the 6/16/61 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME .....

HOME ADDRESS.....

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

HOME TELEPHONE.....

Education

PROFESSIONAL DEGREE(S).....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

6231

- ☐ 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

...TOTAL INVOLVEMENT

The parking field is hardly the place for the mechanization of a Boolean equation, but that's how it goes at Grumman. Perhaps a distinguishing characteristic of the Grumman engineer is his absorbtion ...his total involvement in his job. This has never been a "we planned it that way" kind of management thing. It's just something in the Grumman atmosphere that grew over the years... an Esprit de Corps if you will.

One of Grumman's main attractions is the lack of rigid departmentalization. The engineer here responds to the flexible work situation which gives him the chance to create in those areas where his talents best lie.

Engineers whose own personalities are keyed to flexibility are cordially urged to consider the following immediate positions.

Space Scientists — BS or MS in EE, or Physics with 5-7 years experience in instrumentation, to work in development of measurement devices and measurement systems with emphasis on space sciences and aircraft. Should have knowledge of geophysical and celestial measurement techniques, inertial components and data acquisition systems.

Communications Systems Engineer — Electronic Engineers with thorough knowledge of communications techniques who wish to extend their technical background to new challenging areas. An important phase of this effort will be extensive laboratory development programs in our new Electronics Systems Center using the finest of equipment and facilities. BSEE with a minimum of 3 years experience.

Digital Computer Systems Engineer — BSEE with a minimum of 4 years experience in the analysis design and development of digital computers. Will participate in the integration of digital computer into a complex weapons system. A significant part of the effort will be devoted to extensive laboratory and flight development programs.

ASW Systems Analyst (Underwater Acoustics) — BSEE or BS in Physics with a minimum of 3 years experience in sonar or acoustics. To conceive and work on new detection & classification techniques and advanced airborne, surface & submerged ASW Systems. Work will involve the application of ASW techniques to airborne, hydrofoil, surface ship and submarine phases of the problem.

To arrange an immediate interview, send your resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR-76

GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

Bethpage · Long Island · New York

All qualified applicants considered regardless of race, creed, color or national origin.

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Solve Printed Circuit Assembly and Wiring Problems with Daven's Lollypop Wire Wound Resistor

HERE'S the perfect precision wire wound resistor for printed circuits, miniature plug-in packages or any tight spot where small size and high reliability is needed. Daven's Type 1284 is just one of many Daven plug-in types which exceed all requirements of MIL-R-93-B and MIL-R-9444, plus exceptional overall stability.

The reason: Daven's unique spool design permits low-stress winding of fine resistance wire, thus achieving 2 to 3 times the resistance value previously possible on a miniature bobbin.

Daven specializes in high stability, low temperature coefficient resistors in very small packages. If you have a problem in this area, let us help you solve it.

For a complete catalog on the industry's widest range of resistor types, write today!

THE DAVEN COMPANY, Livingston, New Jersey

A SUBSIDIARY OF GENERAL MILLS

RESISTORS

TODAY, MORE THAN EVER, THE DAVEN ⓓ STANDS FOR DEPENDABILITY

...Another Milestone in Dynamic RCA Tube Design

NOW COMMERCIALLY AVAILABLE FOR TV AND HIGH-FIDELITY CIRCUITS

Novar, RCA's line of 9-pin all-glass integral-base tubes, provides superior performance at lower cost than those high-dissipation type receiving tubes, regardless of base configuration, which were previously manufactured with octal bases and T9 or T12 envelopes.

Among all-glass integral-base receiving tube designs only novar offers:

Larger internal lead diameter—for strong cage support, and high thermal conductivity for very effective heat dissipation.

Wider spacing between pins (0.172")—to assure freedom from voltage breakdown and, therefore, to provide greater assurance of reliability.

Pin length of 0.335"—to insure firm retention of tube in socket.

Pin-circle diameter of 0.687"—large enough to accommodate both T9 and T12 envelopes.

Revolutionary "Dark Heater"—found only in RCA receiving tubes, is additional assurance of high reliability.

First Commercially Available Novar Types Are:

RCA-6AY3, 12AY3, 17AY3 HALF-WAVE VACUUM RECTIFIERS—These novar types are specifically designed for use as damper diodes in horizontal-deflection circuits of TV receivers. Rated to withstand a maximum peak-inverse plate voltage of 5000 volts, they can supply a maximum peak plate current of 1100 ma and a maximum dc plate current of 175 ma. The heater-cathode insulation withstands negative peak pulses up to 5000 volts with a 900 volts dc component. Low-impedance cathode coating withstands high-voltage pulses encountered in TV damper circuits. New RCA "Dark Heater" assures unusually long tube life and reliability.

RCA-7868 POWER PENTODE—For high-fidelity audio amplifier applications, two of these novar high-perveance power pentodes can deliver up to 44 watts of power output in Class AB$_1$ push-pull service. Extra base-pin connections for grids #1 and #2 and special radiator on siderods of grid #2 assure cooler operation...and, of course, the RCA-7868 has the revolutionary "Dark Heater."

Sockets are readily available for novar tube types. For additional information on novar types, call your RCA Field Representative or write RCA Electron Tube Division, Commercial Engineering, Section F-19-DE-4 Harrison, N. J.

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