August 25, 1961

electronics

Review of recent world-wide progress in medical electronics, p 41

Using negative-resistance diodes to handle high power. See p 44

How feedback amplifiers improve Hall-effect multipliers, p 52

A McGraw-Hill Publication 75 Cents

Barium titanate memory cells resist nuclear exposure, p 47

scope

of different measurements

DC TO 1,000 MC!

SPECIFICATIONS ⓗ 185B WITH ⓗ 187B DUAL TRACE AMPLIFIER

VERTICAL (Dual Channel)

Bandwidth:	Greater than 800 MC, usable to 1,000 MC; less than 0.5 nsec rise time.
Sensitivity:	Calibrated ranges, 10 to 200 mv/cm. Vernier increases sensitivity to 3 mv/cm. Attenuator accuracy, ±3%.
Voltage Calibrator:	20 to 1,000 mv, ±3% accuracy.
Input Impedance:	100 K shunted by 2 pf.

HORIZONTAL

Sweep Speeds:	10 ranges, 10 nsec/cm to 10 μsec/cm, calibrated within ±5%. Vernier increases fastest speed to 3 nsec/cm.
Time Scale Magnifier:	7 calibrated ranges x1, x2, x5, x10, x20, x50, x100. Increases maximum calibrated speed to 0.1 nsec/cm, vernier to 0.03 nsec/cm.
Jitter:	Less than 0.03 nsec or 2 mm with x100 expansion, whichever is greater.
Minimum Delay:	Less than 120 nsec, 100 nsec sweep and faster.
Variable Delay Range:	Any portion of the trace may be viewed in detail using the Time Scale Magnifier and the time delay.
Trigger Functions:	(Normal) External trigger 100 mv for 1 nsec or longer, 50 cps to 100 MC. (Sensitive) External trigger 10 mv for 1 nsec or longer, 50 cps to 100 MC. (High Frequency) External trigger 200 mv p-p, 50 MC to 1,000 MC.
Sampling Rep Rate:	100 KC maximum.

SYNC OUTPUT

Amplitude:	Positive, at least 2 volts into 50 ohms.
Rise Time:	Less than 1.5 nsec.
Width:	Approx. 7 μsec.
Recurrence:	One pulse per sample.

GENERAL

X-Y Recorder Output:	Available for making pen-recordings of waveforms in MANUAL, RECORD and EXTERNAL scanning modes.
Beam Finder:	Facilitates location of beam that is off-scale vertically or horizontally.
Accessories Furnished:	187A-76A BNC Adapter (2); 187A-76F accessory adapter (2); 185B-21A Sync Probe.
Prices:	ⓗ 185B Oscilloscope, $2,300.00; ⓗ 187B Dual Trace Amplifier, $1,000.00.

Data subject to change. Prices f.o.b. factory.

ⓗ ACCESSORIES ADD REMARKABLE VERSATILITY TO YOUR 185B SCOPE!

ⓗ AC-16V Delay Line provides 120 nsec delay so that input signal can synchronize the scope, making leading edge of input signal visible on screen. Used with ⓗ 185A-76A Sync. Take-off. ⓗ AC-16V, $200.00; ⓗ 185A-76A, $50.00.

ⓗ 185B-21A Sync Probe, furnished with 185B Scope, provides convenient means for connecting sync signals to scope, increases input impedance to at least 700 ohms. $51.00.

ⓗ 187A-76A Adapters, 2 furnished with scope, convert signal probe to a male BNC connector, add only 2.5 pf to signal probe. $8.00.

ⓗ 187A-76B Adapter converts scope signal probe to Type N connector, adds less than 2 pf to probe. Is not a cable-matching termination. $10.00.

ⓗ 187A-76C 10:1 Divider permits observation of signals as large as 20 volts p-to-p, increases probe input impedance to 1 megohm. $40.00.

ⓗ 187A-76D Blocking Capacitor permits observation of signals ± 600 volts from ground. $3.50.

ⓗ 187B-76E 50 ohm T Connector permits observation of signal on a 50-ohm transmission line, may be used with low reflection load (i.e., ⓗ 908A) to terminate line, observe signal on scope. $35.00.

ⓗ 908A 50-ohm Coaxial Termination is for use with ⓗ 187B-76E (above) as low-power termination for 50-ohm transmission lines. $35.00.

ⓗ 185A-21C/D/E/F Resistive Divider Probes provide high impedance input while triggering from signal itself. ⓗ AC-16W Cable ($10.00) provides flexible connection to ⓗ AC-16V Delay Line. ⓗ 185A-21C (5:1 Division Ratio, 250 ohms input resistance), 185A-21D (10:1, 500 ohms), 185A-21E (50:1, 2,500 ohms), 185A-21F (100:1, 5,000 ohms), $40.00 each.

ⓗ 213A Pulse Generator, provides pulse of approximately 0.2 nsec rise time, 0.4 volts, positive or negative, into 50 ohms. Designed to test rise time in 185B Scope, useful for other extremely fast measurements. Pulse width, approx. 2 μsec; triggered rep rate, 0 to 100 KC; free run, 150 KC. Triggering, approx. ± 0.5 v for more than 2 nsec—will trigger on 185B sync out pulse. $215.00.

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one

for hundreds

hp 185B-

NOW YOU CAN: Sync on any signal rep rate, look at rf sine waves to 1,000 MC! ● See clear, bright pictures, 10 cm full scale width, of events as long as 100 microseconds, as short as 0.3 nanoseconds ● Sync on signals as small as 10 mv ● Effectively see any portion of a 600,000 sq. cm. CRT face, with a sharp, steady trace!

Never before such versatility in a single oscilloscope! The new ⓗ 185B gives you the same steady, bright picture and the same simplicity of operation as conventional low-frequency scopes . . . all the way to 1,000 MC!

Its remarkable versatility makes it ideal for measuring switching speeds of transistors, diodes, computer memory elements; analyzing rf carrier signals by viewing rf directly; measuring phase angle on signals to 1,000 MC by dual channel viewing; analyzing coaxial connectors, cables, attenuators and other devices by observing reflections of fast pulses.

The sampling technique used in the 185B overcomes the inherent limitations of "conventional" high-frequency scopes, to make it the first practical, commercially available answer to the need for measuring and viewing nanosecond pulses. Broad sweep speed capability (10 ranges and vernier, 10 μsec/cm to 3 nsec/cm) and extreme sensitivity increase its usefulness.

Sync sensitivity is ± 10 mv, and, using an accessory delay line, you can sync on the signal being viewed, over the entire dynamic range of the scope, and see the leading edge. 60:1 dynamic range and x100 sweep expansion give you an effective screen area of 600,000 square centimeters, with no loss in brightness, even at maximum expansion.

The ⓗ 185B offers full 10 cm vertical deflection and dual trace presentation for waveform and time comparisons. The scope also can be used to view differential signals. Five modes of operation are provided with the dual channel plug-in. Sync pulse output is provided for triggering external circuits, and X-Y recorder output is also supplied.

Both channels of the ⓗ 187B Dual Trace Amplifier plug-in have independent sensitivity and positioning controls and may be used separately. Calibrated sensitivity controls on both channels include verniers which increase sensitivity to 3 mv/cm. Compact probes produce minimum circuit loading, extreme convenience for such applications as testing transistors. Electronic features of the 185B Scope include low noise and low jitter.

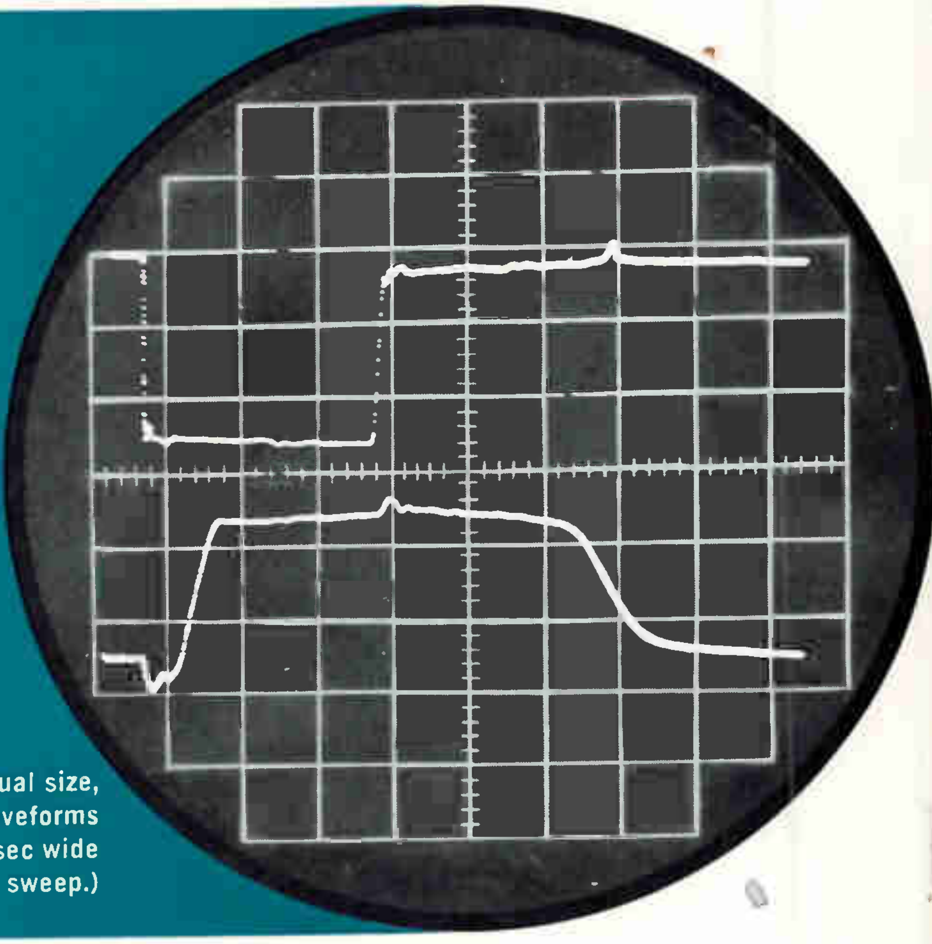
Whatever the frequency range you're concerned with now, this revolutionary new instrument can help you with fast, accurate measurements . . . traces you can view without fatigue . . . and you have the capability built in for tomorrow's measurements into still higher frequencies.

Brief specifications here demonstrate the broad usefulness and versatility of the ⓗ 185B. Call your nearest ⓗ representative or write direct for further information or for a demonstration on your bench.

Today's most versatile

OSCILLOSCOPE

Bright, clear, steady picture this size



hp 185B Oscilloscope graticule, actual size, displaying stimulus and response waveforms for typical transistor test with 75 nsec wide test pulse. (25 nsec/cm sweep.)

DC to 1,000 MC in a single instrument—*available now!*

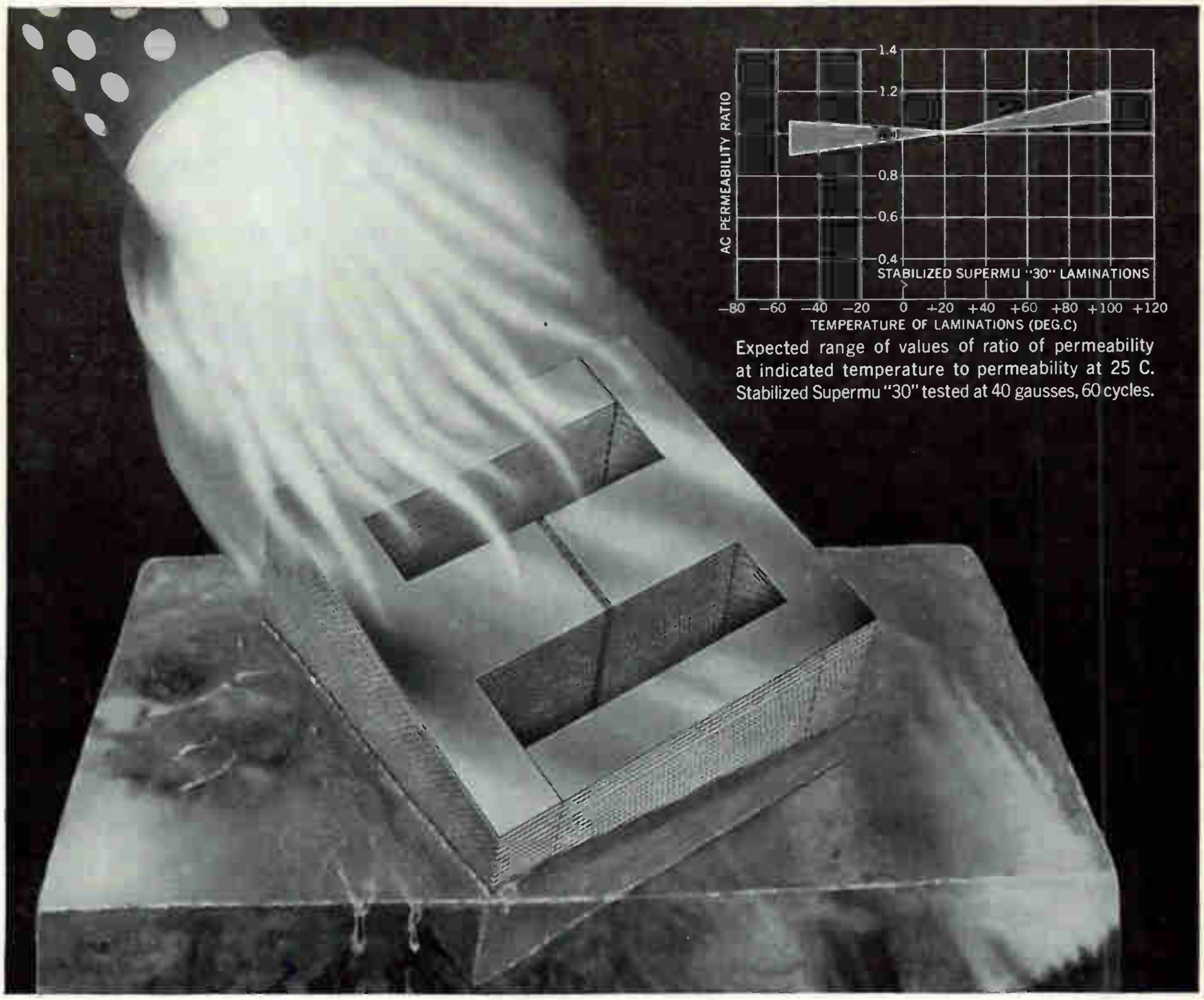
hp®

Turn the page for details!

August 25, 1961

electronics

A McGraw-Hill Publication *75 Cents*



Expected range of values of ratio of permeability at indicated temperature to permeability at 25 C. Stabilized Supermu "30" tested at 40 gausses, 60 cycles.

from Magnetic Metals . . .

THERMALLY STABLE TRANSFORMER LAMINATIONS

If you're designing a transformer or reactor that must maintain constant inductance under the blazing desert sun or in the sub-zero cold of the Arctic or outer space, you need our thermally stable Supermu "30" laminations. They're the only temperature-stabilized laminations available anywhere.

Special composition and the ultimate in annealing control stabilize over a wide temperature range the permeability of thermally stable Supermu "30" laminations. Meticulous care in stamping eliminates burrs and preserves absolute flatness.

With performance characteristics effectively stabilized, thermally stable Supermu "30" offers the only available solution to thermal design problems, and is also of particular value where you want to miniaturize components.

Laminations of thermally stable Supermu "30" are made in all standard sizes and thicknesses. Count on two-week delivery. Custom designs are available on special order. Our engineers are ready and well qualified to help you make the most of this exceptional lamination material. Write or call today.

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New multi-purpose

BROADBAND FERRITE AM MODULATOR

DELIVERY FROM STOCK

MODEL X158A
Price: $250.00

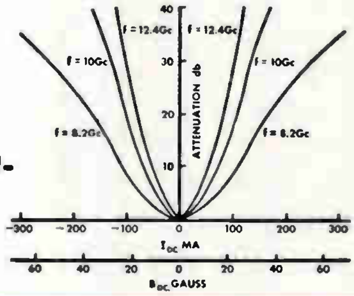
- Covers entire X-band, 8.2 to 12.4 Gc
- Metallized plastic construction for high frequency audio response
- Low driving power required
- 30 db minimum dynamic attenuation
- Low insertion loss—with no coil current

First to cover the entire X-band, 8.2 to 12.4 Gc

FXR's new X158A broadband ferrite modulator is the first absorption amplitude modulator to provide full coverage of X-band, 8.2 to 12.4 Gc. A primary use of this unit is to provide a clean AM microwave signal for high accuracy measurements. Previously any attempt to modulate a microwave oscillator left much to be desired because of error-producing FM, jitter and double moding.

The modulator coil of the X158A has been designed so that any standard, 1 watt, co[illegible]cial audio oscillator will provide substantiall[illegible]% modulation at 1,000 cps.

ATTENUATION-SOLENOID CURRENT



APPLICATIONS

Microwave Measurements
As an amplitude modulator for high accuracy microwave measurements

Microwave Transmitter Modulation
With proper biasing of the control solenoid low distortion modulation is obtained over the audio range

Fast Microwave Switching
For front panel or remote switching of signal generators and other low power units

Electrically Controlled Microwave Attenuation
For electrically controlled microwave attenuation of system energy from either remote or local positions

SPECIFICATIONS FOR MODEL X158A FERRITE MODULATOR

Freq. range: 8.2 to 12.4 Gc	Coil characteristics: 35 millihenries 55 ohms @ 1 kc
Max. insert loss: 1.0 db	Max. solenoid current: 300 ma DC
Min. dynamic attenuation: 30 db	Insertion length: 5"
Max. input and output VSWR: 1.20	Cover flanges to mate with: UG-39/U
Max. average RF input power: 2 watts	Waveguide type: WR90

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electronics
August 25, 1961 Volume 34 Number 34

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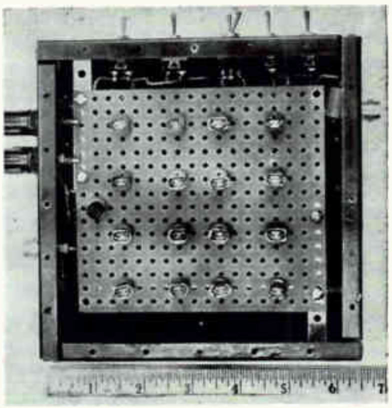
CROSSTALK

FOR THE FIRST TIME, the non-profit military electronic systems engineering firm, the Mitre Corp., will be in charge of an entire Air Force command and control system. Mitre and the contracting Electronic Systems Division of the Air Force Systems Command will together act as systems engineers on future large electronics systems also—a role formerly given private industry. Industry will be used as associate contractors for hardware. During a week-long visit to ESD Headquarters at Hanscom Field, Mass., Associate Editor Mason obtained an exclusive report on this significant step in Air Force procurement policy. His report-in-depth, detailing how the policy evolved and previous Air Force use of weapons system management firms, appears on page 22.

PROTOTYPE 16-bit matrix memory shown in the accompanying photo consists of the barium titanate memory cells shown in detail on the front cover. Use of these memory elements in nuclear resistant, long-term, random-access memories is described in this issue by A. B. Kaufman of Litton Systems. His article begins on p 47.



PROBLEMS involved in making transient light measurements with phototubes are discussed by H. E. Edgerton and R. O. Shaffner of MIT in the informative article beginning on p 56.

Edgerton has been concerned with the field of underwater flash photography and stroboscopy for several years; his ELECTRONICS articles in this area have dealt with underwater camera systems (p 62, April 8, 1960, coauthored with S. O. Raymond) and a sonar pinger (p 93, June 24, 1960).

Coming In Our September 1 Issue

PLASMA ENGINEERING. Assistant Editor Wolff's series on plasma engineering continues next week with a survey of the possible applications of plasma. You'll read about experiments in thermonuclear fusion, MHD and thermionic power conversion, spacecraft propulsion and plasma electronics. Latter topic involves research into the use of plasma for such devices as microwave traveling-wave amplifiers, backward-wave oscillators, uhf parametric amplifiers, and phase shifters. Semiconductor plasma devices are also discussed in this article, which follows one on measuring plasma parameters (p 33, Aug. 14, 1961) and an introductory article on generating and heating plasma (p 47, July 14, 1961).

Raytheon Reliability-Controlled Tubes are certified to have an average life span of more than 10,000 hours when used under approved conditions — with full credit for failure within *1,000 hours* — at no increase in price!

Through the use of special design and manufacturing techniques, Raytheon now brings you a line of Reliability-Controlled Tubes to meet your most critical needs for long life and reliability. Each Reliability-Controlled type is monitored by tests far more severe than those normally encountered in service and is backed up by an unprecedented 10,000 Hour Life Certificate.

Applicable to shipments of 100 tubes or more from factory or Raytheon Distributor stock, Raytheon's 10,000 Hour Life Certificate assures you of:

1. Full credit for any and all tube failures which occur during the first 1,000 hours of service.
2. Proportional credit on the shipment lot to the extent that failures prevent that shipment lot from achieving an average life of 10,000 hours.

Eight Reliability-Controlled types are now available — 6AH6WA, 6AN5WA, 5670, 5654/6AK5W, 5755, 6414, 0A2WA, 5651WA — more types in development. Each data sheet contains a section devoted to operating conditions and ratings recommended to achieve the long and reliable service built into these tubes. Full technical data and complete details on the new Raytheon 10,000 Hour Life Certificate are available from Raytheon Company, Industrial Components Division, Newton 58, Massachusetts.

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CIRCLE 5 ON READER SERVICE CARD

COMMENT

Patent Legislation

I've just been reading your comments in *Crosstalk* of the June 2 issue (p 4) regarding proposed revision of patent law as applied to R&D done under government contract. A great deal of what you say has validity.

I find, however, some of your statements amusing when more widely applied, i.e. to the relationship between a laboratory or development organization and its employee. To my limited knowledge, it is standard practice for an employee, upon hire, to sign away all rights to any invention he may conceive of while in the employ of the laboratory or development organization whether related to his R&D activities or not.

To parallel your words, . . . the researcher has contracted for goods and services. . . . In this situation . . . no one has seen fit to raise the spectre of danger to free enterprise.

. . . there is considerable justification for the government to retain ownership of an invention arising in the course of R&D paid for by the government. It is apparent that the invention would not have occurred if the opportunity were not provided for by government sponsorship. . . .

ALBERT GOODMAN
SANDIA CORPORATION
ALBUQUERQUE, N. M.

. . . It has been very interesting to read the lively discussions in *Comment* concerning patent legislation. My experiences with patents leads me to suggest two concrete propositions:

(1) A modest "license fee" be collected by the Commissioner of Patents for every valid patent from all the companies which are using it profitably. A committee would determine the amount [of the fees] and would distribute the collected funds to inventors. . . . This program should be fully independent of evaluation by private industry.

(2) Employees obtain the right to apply for a patent if the company is not interested in applying.

These measures would [encourage] scientists and engineers to work on their own projects. I believe a successful scientist or engineer is often a better judge of the merits of a project than an administering manager. . . .

I. ZAKARIAS
PICOFARAD ELECTRONIC INSTRUMENTATION
BEACON, N. Y.

Our readers may be interested to know that Mr. Zakarias has had patent experiences in Hungary as well as in this country. In Hungary he headed his own company (also named Picofarad) before it was nationalized. He left for the U.S. after the October 1956 uprising. While in Hungary he worked on synchronous detection, on which, he says, he obtained a U.S. Patent (number 2,208,091) together with three other inventors. Officials in Hungary will not credit him for his work, he says, because of his non-conversion "to Communistic theories and practices" and his "without permission" exit from Hungary. He has contributed articles to ELECTRONICS *as far back as 1948 and recently presented a paper at the Fourth International Conference on Medical Electronics entitled "Scientifically Checkable Lead System for Vectorcardiography".*

Ions and Health

In Comment of the May 27, 1960 issue (p 61), you state that you have a file of references and sources on research regarding the biological effects of atmospheric ions on the human system.

My background is in nuclear physics and instrumentation and I am therefore intrigued with the industrial applications of this work.

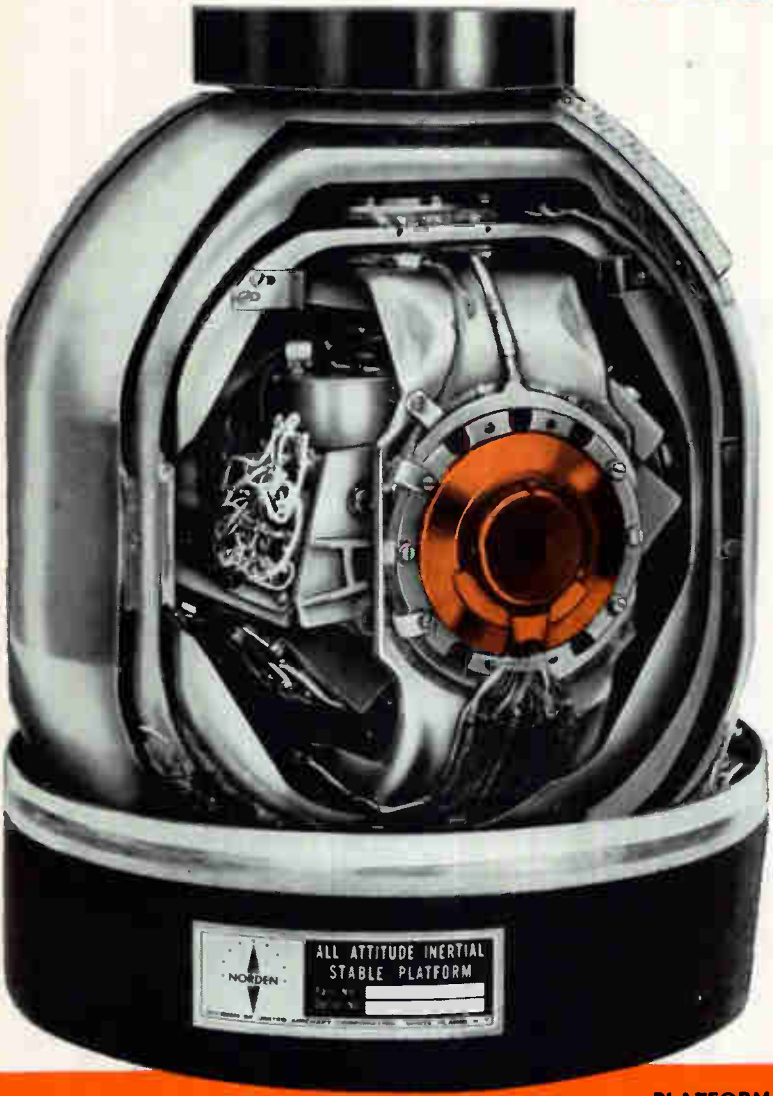
I would appreciate whatever information you might have.

RALPH E. WHITE
ALTADENA, CALIF.

A list of 26 references has been sent to Mr. White.

In a future issue we hope to have additional interesting comments on atmospheric ionization by people prominent in the field.

INLAND d-c torque motors save critical weight in guidance systems



Norden Miniature All-Attitude Inertial Platform uses four Inland torque motors, one for each gimbal axis.

Norden specifies these Inland d-c torque motors because of their compact pancake shape, low-power input and direct torquing. In addition to providing the obvious weight and space reduction, Inland's direct drive positioning eliminates gear train problems such as backlash.

Norden engineers say, "The linearity of the Inland torquers is excellent over a wide range so that precession rates may be accurately established. The torquer fixed field is carefully stabilized so that the torquer gradients will be constant over long periods of time."

Inland d-c pancake torque motors with high torque-to-inertia ratios and linearity of output provide all the advantages of direct gearless servo positioning in a complete line over the full range of 0.1 to 3,000 pound-feet.

PLATFORM SHOWN ½ SIZE

COMPARE THESE TYPICAL INLAND TORQUER RATINGS

	T-1321-A	T-2136-A	T-2108-B
Peak torque, oz. in.	20.0	35.0	60.0
Volts at peak torque, stalled at 250°C	48.0	26.0	25.6
Amps at peak torque	1.21	1.6	1.24
Total friction, oz. in.	0.5	0.8	1.5
Rotor Inertia, oz. in sec²	.001	.007	.011
Weight, oz.	5.0	9.0	14.0
Dimensions (inches):—O.D.	1.937	2.81	2.81
I.D.	.625	1.00	1.00
Thickness	.50	.63	1.00

For complete catalog with engineering data, outline drawings and specifications on these and other Inland d-c pancake torquers, write Inland Motor Corporation of Virginia, Northampton, Massachusetts. Dept. 12-8

INLAND MOTOR CORPORATION OF VIRGINIA
A SUBSIDIARY OF KOLLMORGEN CORPORATION
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NEW additions to a proven line of R-F equipment...

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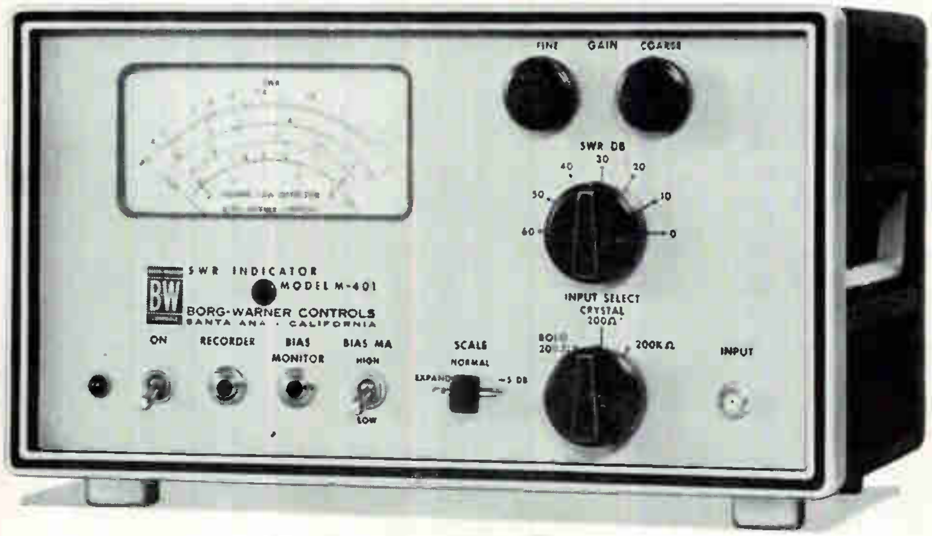
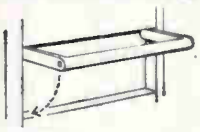
New styling...new convenience... new versatility...new accuracy!

Now, a fresh new approach to precision laboratory test instruments...designed and engineered by Borg-Warner Controls to meet the most demanding needs of industry. The result of 15 years of leadership in high-power radio-frequency equipment, these new instruments are superior in styling...in convenience and versatility...in accuracy and performance.

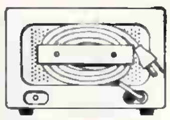
Clean, functional design. Handsome two-tone brown and beige color schemes. Simplified controls—no crowding or confusion of knobs. Finest quality meters for quick, clear, accurate readings. Most important of all, better resolution due to improved design. Don't buy any laboratory quality test equipment until you've examined these advanced new models!



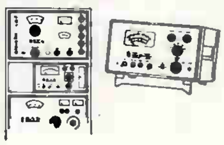
FOLD-AWAY CARRYING HANDLES



WIND-UP POWER CORD



VERSATILE! *All instruments can be used on bench, or rack-mounted*



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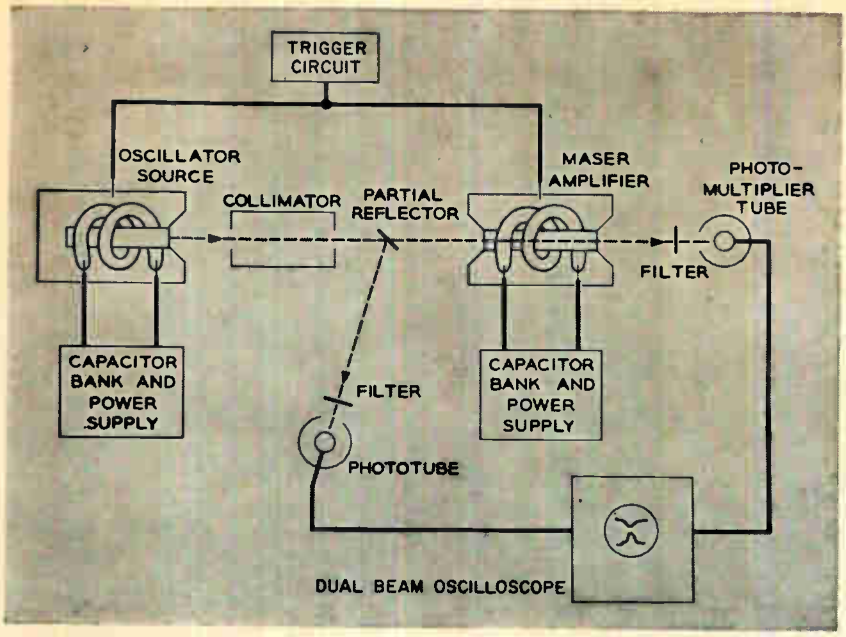
ELECTRONICS NEWSLETTER



Ruby Masers Operate as Light Amplifiers

PULSED RUBY optical maser has amplified coherent light from a conventional ruby maser. Net power gain was a factor of two. Light from the source maser is directed into the amplifying ruby so that no part of it hits the side of the ruby or is masked by the amplifier housing (see sketch). The ends of the amplifying ruby are not silvered.

Work with the tandem laser was reported this week at WESCON by P. P. Kisliuk and W. S. Boyle, of Bell Telephone Laboratories. Gain was found to be a function of temperature of the amplifier and the pumping power. The factor-of-two gain was observed at −40 C. Housings permitted liquid nitrogen cooling.

To observe amplification directly, coherent light must be distinguished from the maser's natural fluorescent light. This was accomplished by generating coherent light intense enough to overcome fluorescent light. Input and output signals were monitored by multiplier phototubes and displayed on a dual-beam oscilloscope.

The researchers expect to obtain greater amplifications with more precise control over temperature and other variables.

In Cambridge, Mass., meanwhile, Trident Corp. reported preliminary gain figures for another ruby laser. Driven by a ruby oscillator, the pulsed ruby amplifier has yielded gains of 25 to 100 percent per inch of active length of the amplifying crystal. The experiments were run at high power levels. Higher limits are possible. Work is aimed at determining the effect of changing variables on amplifier performance and refining gain reading accuracy.

Laser "Doubler"?

PHYSICISTS at the University of Michigan reported last week that they have produced a first overtone light beam with a laser. A high intensity, monochromatic red laser beam, at 7,000 Angstrom units wavelength, was focused into a quartz crystal. A considerably weaker second harmonic of monochromatic deep blue—almost invisible violet—at 3,500 Angstroms was emitted. Michigan is also using its high-power laser on a variety of other materials.

Patent Office Proposes Higher Fees, Time Payment

FURTHER DETAILS on the Patent Office's plans to revamp procedures to shorten processing time (ELECTRONICS, p 14, July 14) were reported this month by Patent Commissioner David L. Ladd.

A proposed fee system is patterned along that used in Europe. Nominal fees would be charged upon filing. But if a patent is granted, additional fees of $100, $300 and $500 would be charged five, nine and 13 years, respectively, after granting. If fees are not paid after a grace period, the patent would lapse.

This system, Ladd indicated, would in time limit patents in force to those of long-term value and would clean out deadwood—such as patents filed only for short-term defensive reasons. He doesn't think the increasing fees would deter filing of worthwhile patents. In Germany, he said, installment fees total $2,500, yet Germans file more patents per capita than Americans.

Other steps being taken by the Patent Office include research into electronic information retrieval systems.

Orbiting Needle Relay Belt Given Go-Ahead

POLICY STATEMENT by the National Aeronautics and Space Council, with approval of President Kennedy, apparently clears the way for launching of Project West Ford. This is the orbital scatter communications experiment proposed by MIT Lincoln Laboratory, initially dubbed Project Needles (ELECTRONICS, p 43, Sept. 30, 1960).

The proposal triggered protests from optical and radio astronomers that the orbiting belts of tuned dipoles would interfere with their research. At the International Astronomical Union assembly in Berkeley, Calif., last week, for example, the Union's president termed the belt proposal a "grave danger".

The Space Council's statement says the first exploratory test probably would not have an adverse effect on any branch of science. The U.S. has pledged no operational system will be launched until experimental results are analyzed. Astronomers have been invited to help determine if a needle belt would obscure astronomical observation or reception.

In exploratory test, 75 pounds of dipoles tuned to 8,000 Mc will be released from a rotating dispenser on a satellite. After 30 days, the belt of 350 million dipoles will extend around the earth. It can be used with highly directive microwave antennas to provide many high-capacity, intercontinental communications circuits. Twin 60-foot antennas for initial test are ready at Millstone Hill, Mass., and Camp Parks, Calif., but launching date remains classified.

Copper dipoles, 1.77-cm long, to be used in first test could last 10 to 20 years, depending on belt altitude and inclination. Lincoln Lab is checking into use of white tin alloy dipoles, which would become transformed into gray tin powder pushed into the atmosphere by solar radiation pressure.

Russian Spaceship Had Three Radios, Dual Tv

SOVIET SCIENTISTS, at a press conference following the orbital flight of Vostok II, outlined the communications systems carried by the spaceship. But information on other instrumentation and controls was scanty.

Long-range communications were handled by a-m telephone-telegraph transmitters. They operated at 15.765 and 20.006 Mc and used a common antenna with a filtering system. When Vostok II was over Russian territory, messages were sent and received with an f-m system operating at 143.625 Mc. Bandwidth was ± 30 Kc. Messages from the ship were beamed at specific ground stations and conversely.

The pilot, Gherman Titov, also used a tape recorder. Recorded comments were transmitted by the "ultrashortwave" system over Russia. Titov said he never used his telegraph key because the radios functioned well.

During the flight, Titov was observed by two tv systems: one narrow-band with a definition of 100 lines and the other broad-band with a definition of 400 lines. Both transmitted 10 pictures per second.

All the radio receivers in the ship used semiconductor devices. During an "eyewitness" account of the launching, broadcast August 7, the announcer said that the biophysical telemetering transmitters were "under the spacesuit", indicating these were miniaturized as well.

Is Smell Really Change In Nose Cell Potential?

ELECTRONIC NOSE with more objectivity than the human nose is a possible result of a long-range research project underway at Armour Research Foundation. Researchers theorize that adsorbent surfaces in the nose are highly selective with respect to molecular structures of adsorbed vapors. The signal in the olfactory nerve probably comes from a change in interface potential.

To check this out, ARF is using a variable capacitor to compare contact potential caused by the same vapor on a variety of solids. If electronic effects are selective, olfactory devices may be possible. Such a device could be used in studying food aromas, food spoilage detection, industrial or military warning systems, even for finding out whether there are smells in space.

Tack-Sized Dosimeter Developed at Battelle

RADIAC DETECTOR, a new, miniaturized fast neutron dosimeter about size of a carpet tack, is being developed by Battelle Memorial Institute for U. S. Army Signal Corps.

Fast neutrons passing through the dosimeter knock some of silicon atoms from their normal positions in an 0.1 by 0.03-inch silicon disk mounted between two electrical contact pins, permanently changing electrical properties of the silicon. Change in electrical properties is to be measured in terms of tissue rads—units of radiation damage to human tissue.

In Brief . . .

U. S. SPACE PROGRAM scored one hit and two misses last week. Explorer XII went 54,000 miles into space in search of data on magnetic fields. A Blue Scout rocket, which was to send radiation instrumentation 140,000 miles out, failed. Also failing, in a test, was the powerful F-1 rocket engine for Apollo.

ADVANCED RESEARCH Projects Agency has ordered 40 portable seismographs from Geotechnical Corp, under an $8 million contract. The instruments will be used in the Vela Uniform program to detect explosions.

OTHER MAJOR MILITARY contract awards include $1.6 million to Collins Radio, from Air Force, for airborne transceivers; $1 million to Microwave Associates, from Navy, for magnetron tubes; over $½ million to Fairchild Semiconductor, from Air Force, for transistors to be used in Minuteman program; a total of $1 million to Jerrold Electronics, from FCC and military agencies, for tv, communications, control and antenna systems; more than $2 million to Minneapolis-Honeywell, from General Dynamics, for rate gyros for Atlas guidance.

NORTH AMERICAN Air Defense Command tested its electronic facilities last week with a simulated attack by 549 missiles and 420 bombers.

RUSSIANS are proposing stationary satellites large enough to carry crews. Orbit of 24 hours would make them appear immobile.

TV BROADCASTERS have petitioned FCC for extension of the Oct. 2 deadline on comments regarding uhf-tv proposals. Association of Maximum Service Telecasters, said to represent 150 stations, asked for six more months.

ASME, in cooperation with American Standards Association, is developing calibration techniques for pressure, temperature, fluid flow and liquid level measuring systems.

First "off-the-shelf" high resolution display for low cost computer monitoring

General Dynamics/Electronics' new S-C 1090 is the first "off-the-shelf" computer display featuring high character legibility on a large CRT screen. The S-C 1090 incorporates an improved 19-inch CHARACTRON® Shaped-Beam Tube and is capable of displaying 1000 flicker-free, high-resolution characters simultaneously anywhere on the tube face. Thirty thousand or more characters per second may be displayed with extreme brightness and contrast.

MOST VERSATILE DISPLAY. The S-C 1090, operating either on-line or off-line, is designed to monitor digital computer systems and present data for decision or information purposes. Alphanumeric or symbolic characters, and vectors may be presented singly or in combination.

Maximum flexibility for various applications has been provided by a number of special modular optional features for the S-C 1090 display which include:

1. *Internal Test Pattern Generator*—permits complete set up and calibration without tying up the computer or data handling system, saving time and expense.

The S-C 1090 display is compact, offers full 19-inch screen

2. *Vector Generator*—capable of drawing straight lines between points on the tube for graphic presentations.
3. *Format Generator*—reduces the S-C 1090's input requirements and doubles display rate from computer.
4. *Input Register*—provides console with buffer storage for position and character selection information.
5. *Offset & Expansion*—can enlarge any segment of tube screen to full screen size for more detailed view.
6. *Category and Feature Select*—allows selection of information for display without computer intervention.

SUPERIOR CHARACTER FORMATION. The CHARACTRON tube's unique method of shaped-beam character formation offers proven advantages over less precise line-segment, dot, or scan character forming techniques.

Symbols and characters are obtained by extruding electron beams through stencilled openings in a metal disc called the matrix. After passing through the matrix, the character-shaped beam is directed to an appropriate spot on the tube face. Most matrix have 64 characters.

COMPACT DESIGN. The S-C 1090 is a compact unit measuring 32 inches in width, 45 inches in height, by 66 inches in length. The unit's low silhouette allows operators to actually look over the top of the console for simultaneous viewing of the tube screen and projected large screen displays.

S-C 1090 APPLICATIONS. The S-C 1090 is capable of tabular, situation or graphical presentations and can be used in a wide range of computer intervention, monitoring and retrieval jobs. It is suitable for laboratory, simulation, Air Traffic Control and surveillance applications.

For additional information on the S-C 1090 Direct View Display or other General Dynamics/Electronics readout and display systems, write General Dynamics/Electronics, Information Technology Division, Dept. B-46, P. O. Box 2449, San Diego 12, Calif.

GENERAL DYNAMICS | ELECTRONICS

WASHINGTON OUTLOOK

CONSOLIDATION OF MILITARY BUYING of common-use electronic parts and components is being held up pending a more comprehensive decision by Defense Secy. McNamara to set up a "defense supply agency" which would handle billions of dollars worth of other non-specialized support items bought in bulk by the military.

The new agency is expected to be organized within the next several weeks. It would take over procurement and other supply management tasks now handled by so-called "single managers" in the services for food, clothing, fuel, construction equipment, and other essentially commercial-type products.

Up to now, the idea has been to appoint one of the services to do all the buying, warehousing, distributing, etc. for all the other services. Under a proposal now being studied by McNamara, the new agency would pull together these functions and reduce buying of common-use items by the services. But military contracting agencies would continue to be responsible for procurement and supply management of the many billions of dollars worth of more specialized arms and equipment not considered to be of a common-use variety.

FINAL VERSION of the Congressional defense appropriation bill earmarks $705-million for Air Force bomber production and development which the Kennedy administration doesn't want. Congress voted $525-million to continue B-52 or B-58 production (current schedules call for phasing out production next year) and $180-million extra to speed up B-70 development. The administration's plan is to spend only $220-million.

The additional B-70 money would be used to reactivate development work on electronic subsystems under the Congressional plans. But unless the administration is willing to give in to political pressures—which, as of now, is unlikely to happen—the Pentagon will be required to go along with present bomber schedules this year.

ELECTRONIC INDUSTRIES ASSOCIATION and other defense contractor groups have been invited to a Pentagon brainstorming session sponsored by the Air Force late this month to discuss what Lt. Gen. Mark Bradley, Jr., deputy chief of staff for systems & logistics, calls "advanced methods of procurement".

The general is dissatisfied with current buying practices, feels the policies fail to "reward a supplier who does a good job and penalize one who doesn't". He is pushing for "new ways of doing business".

LATE NEXT YEAR, the National Aeronautics and Space Administration will put a communication satellite into a 22,300-mile high synchronous orbit about the earth. A $4-million dollar contract has been awarded Hughes Aircraft Corp. to build three flight model satellites. Dubbed Syncom a three-stage Delta vehicle will boost the satellite into orbit.

The NASA project will relay telephone and data transmissions, but will not provide tv bandwidths. Test frequencies will be 8,000 Mc from ground to the satellite and 2,000 Mc from the satellite to ground.

The program is similar to the Army's Project Advent that is designed to provide a military satellite communications network using three or more synchronous satellites. NASA will use Army ground facilities for its initial experiments.

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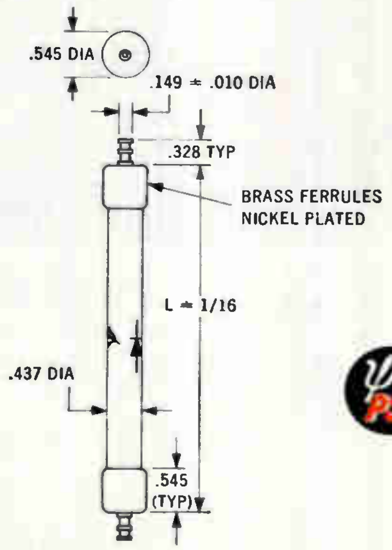
PS1450	10,000V	250mA	125mA	1 μA max	4 5/16"
PS1455	15,000V	200mA	100mA	1 μA max	6 1/16"
PS1460	20,000V	200mA	100mA	1 μA max	6 1/16"

Inverse current @ PIV @ 100°C 50μA max.



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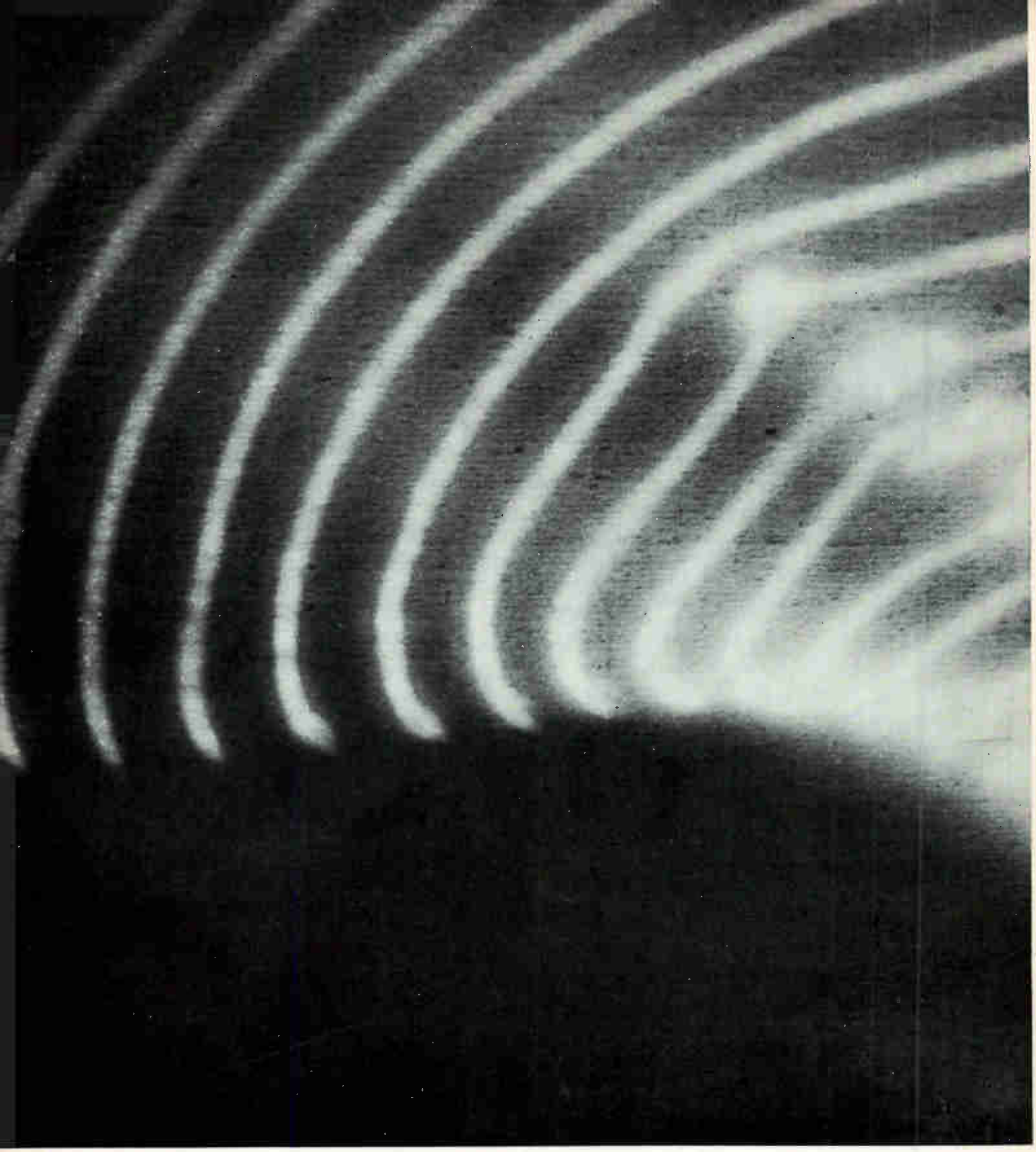

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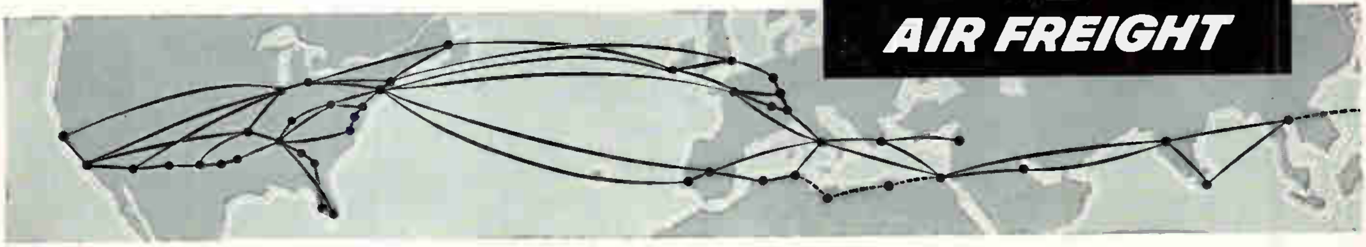

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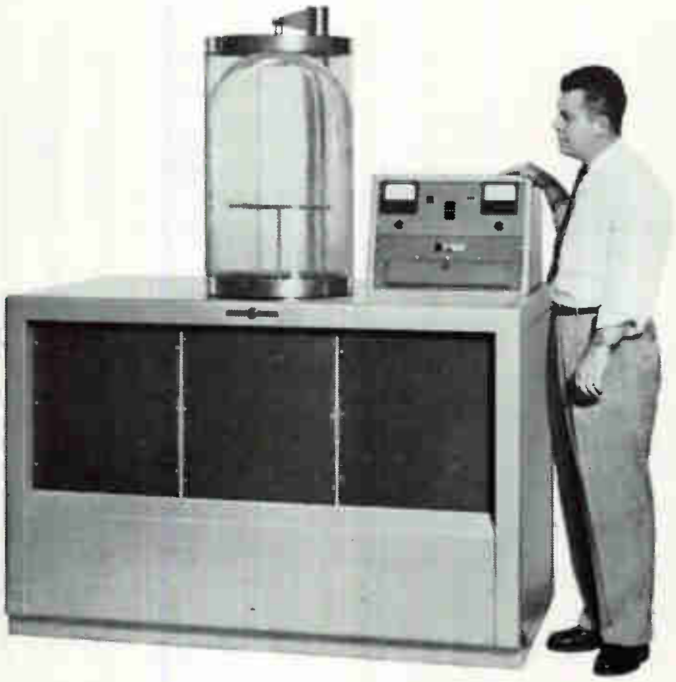

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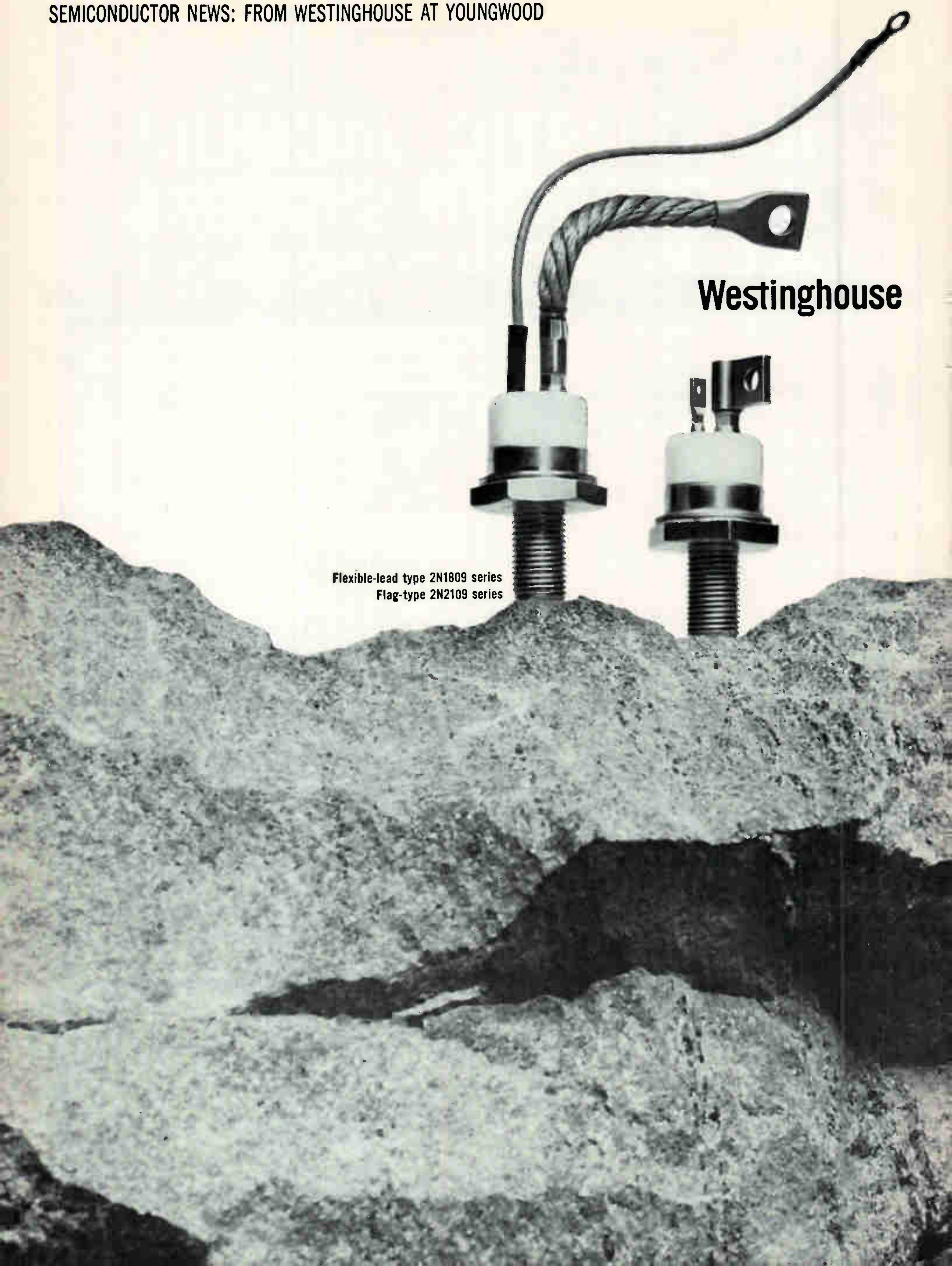
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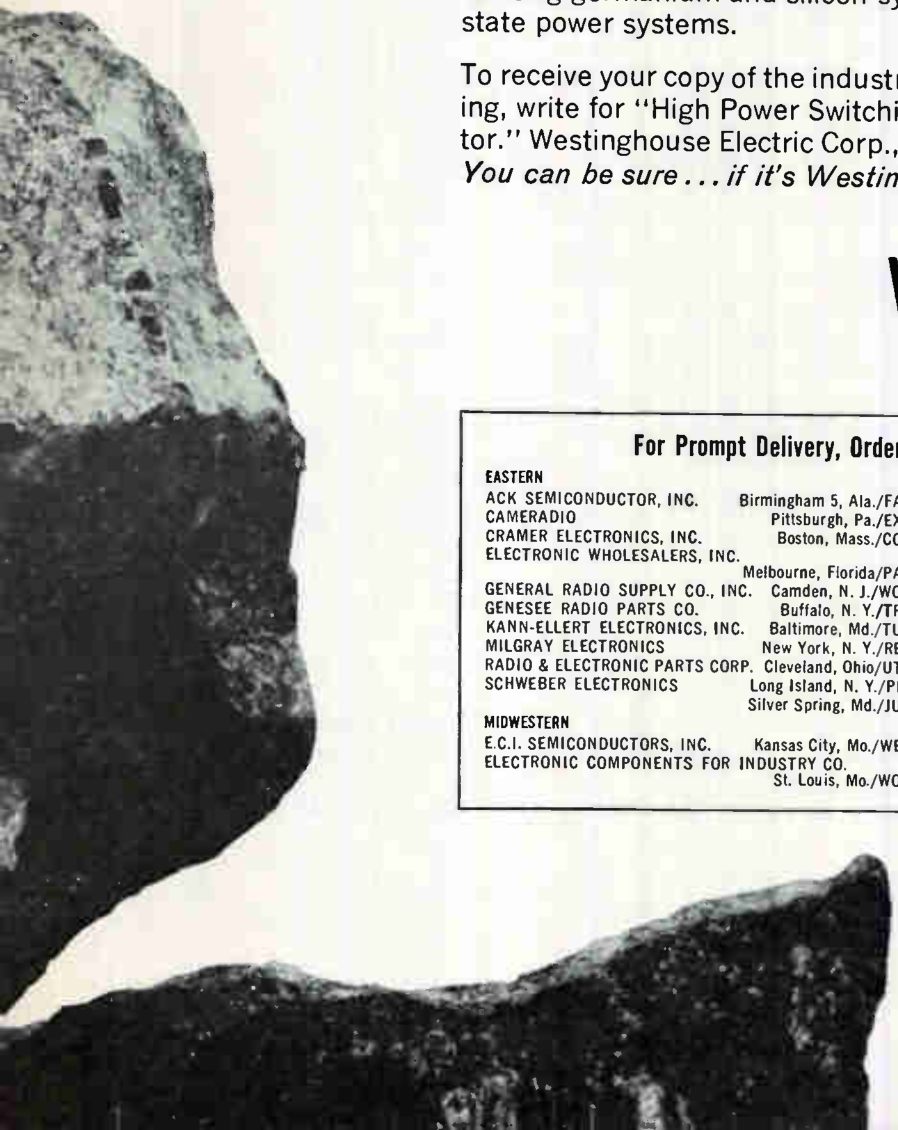

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Air Force Uses Non-Profit Firm

By JOHN F. MASON,
Associate Editor

HANSCOM FIELD, MASS.—Private industry will no longer be awarded weapon systems management contracts by the Electronics Systems Division (ESD) of the Air Force Systems Command (AFSC), ELECTRONICS was told by Col. J. C. Bogart, special assistant to Maj. Gen. K. P. Bergquist, commander of ESD.

Beginning with the recent 425-L system award—the combat operations center for the North American Air Defense Command—the non-profit Mitre Corp. will be utilized as systems technical adviser to ESD. This joint Air Force/non-profit-corporation team will carry out the weapons systems management job formerly given to industry. Industry is brought into the program as associate contractor teams for major hardware subsystems.

This is the same mechanism that has been used in the Air Force missile and space programs for the past seven years—first using as systems adviser the Ramo-Wooldridge's Space Technology Laboratories (STL), a profit-seeking organization, and later the Aerospace Corp., which is non-profit.

The only remaining division in AFSC not using the associate contractor concept is the Aeronautical Systems Division, which, according to ESD's Bogart, will probably not acquire a non-profit corporation. Reason being that ASD has built up a good inhouse capability over the years and also, its business is declining rather than increasing.

Although Mitre was formed by USAF in 1958 to support air defense systems and has acted as scientific adviser on all of USAF's 15 or so command and control system projects, this is the first time Mitre has carried an entire project as systems engineer. In the past, Mitre has advised ESD, which in turn handed the whole package to a prime contractor as systems engineer. The prime managed the project, awarding subcontracts for subsystems. Under the new setup, ESD, with Mitre's help, will fill this position, awarding direct contracts to industry for specific subsystems.

In the case of the 425-L system, the Burroughs Corp. was designated an associate contractor by ESD as hardware integrator. Burroughs will award subcontracts and deal with suppliers to put the computers, display and internal communications into a system. (Outside communications will utilize USAF's 480-L communications network.) The Mitre Corp., in spite of its management position with the Air Force, is nevertheless under contract to ESD and therefore also is designated an associate contractor. The Systems Development Corp. has been named subcontractor to Mitre, responsible for "softwear" integration—computer programming. (The fact that SDC is also non-profit is coincidental and does not form a precedent.)

The associate contractor concept was begun by the Air Research and Development Command's Ballistic Missile Division in 1954 by its commander, B. A. Schriever, then Brig. Gen. At this time, Ramo-Wooldridge was commissioned to set the basic system concepts and specifications, and then coordinate and direct, from a technical standpoint, the weapon-building work of several large companies.

Occupying an intermediate position between USAF and the industrial contractors, Ramo-Wooldridge with its Space Technology Laboratories (STL), performed contract services of a technical nature which in other weapon systems procurements were assigned directly to the prime (or integrating) contractor or retained in some part by the government agency.

"Air Force rationale for hiring STL (and later Aerospace) was compounded of two main elements: technical competence and technical objectivity."

This statement was made by the Committee on Government Operations in congressional hearings on "Air Force Ballistic Missile Management (Formation of Aerospace Corp.)," May 1, 1961.

In the first instance, according to the committee's report, neither the Air Force nor industry possessed in any single agency the technical competence and resources required to build the ICBM.

As for technical objectivity, the committee felt that "the systems engineer, as technical judge or arbitrator in the technical conflicts that arise in the progress of any project, must constantly resist pressure or resolve conflicts to preserve the technical integrity of the weapon system.

"For these reasons, it is contended, the industrial contractors must be directed by an agency free of interest in hardware production. Only in this way can objectivity be assured and the Government's interest protected."

Ramo-Wooldridge, however, was a profit-seeking organization. To protect its objectivity, two things were done. R-W walled off its missile work from its other corporate operations; and USAF put a "hardware ban" on the firm. It was not eligible to receive contracts for developing or producing hardware components for these missile projects.

"In the long run, however, this arrangement did not work," the committee reported. "Other companies resented STL's access to their technical data and its position of advantage in carrying on long-range weapon and space studies for USAF." Also, R-W was "keenly alive to the fact that the real moneymaking potential was in hardware production."

The next step was to make STL a separate corporation while the remaining part of R-W merged with Thompson Products to become Thompson-Ramo-Wooldridge, Inc. Because of the old ties, however, USAF retained the hardware ban on Thompson-Ramo-Wooldridge.

However, according to the report, STL grew and assumed more and

as Electronic System Engineer

more responsibility in the missile and space effort. It was suggested that STL become a non-profit organization. Executing such a complicated maneuver, however, was finally abandoned and USAF "created a new non-profit corporation—Aerospace—to coexist with, and even supervise, STL."

Last year, STL reintegrated with Thompson - Ramo - Wooldrige, the hardware ban was removed and new business is coming in. In view of this, the committee "believes that the Air Force should close out, as rapidly as possible, contract functions with STL which afford privileged access to industry data and technical decision-making responsibilities affecting the industrial careers of the associated contractors.

"As matters stand now, STL and the new Aerospace Corp. between them are to encompass the technical management functions considered essential in missile and space weaponry which are not believed suitable for transfer to industry and yet which USAF does not have the in-house technical resources to perform."

STL's remaining work for the Ballistic Systems Division is to perform systems engineering and technical direction for the Atlas, Titan, and Minuteman programs, until they are completed. "Follow-on work on these missiles will probably be taken over by Aerospace," ESD's Bogart said.

Aerospace is responsible for portions of Samos, Dyna-Soar booster, Advent booster, Bambi, Mercury booster, Saint, Transit and Vela Hotel. Besides the above technical program operations, Aerospace is also responsible for systems research and planning, laboratory operations, technical services and administrative support.

There are critics of the non-profit corporation on several fronts. Industry asks, "What can they do that we can't do?" Critics in government feel that large programs should be managed by government personnel.

However, "it is unlikely that developments on either the government or industry side will come to the point of eliminating such intermediary contract agencies," the committee said.

Schriever told the Air Force Association Industry Seminar last Sept., "In my opinion, the evolution of organizations such as Aerospace and Mitre mark the most significant change in our management policy since the technological explosion began."

USAF has other contractor organizations engaged in technical management and related functions. Lincoln Laboratory is a non-profit organization associated with the Massachusetts Institute of Technology. It provides a technical resource for development, design and basic research in electronics, sensors and data processing. Available to all the military services and the Advanced Research Projects Agency, Lincoln Labs does technical work for ESD in the planning and development of command and control systems.

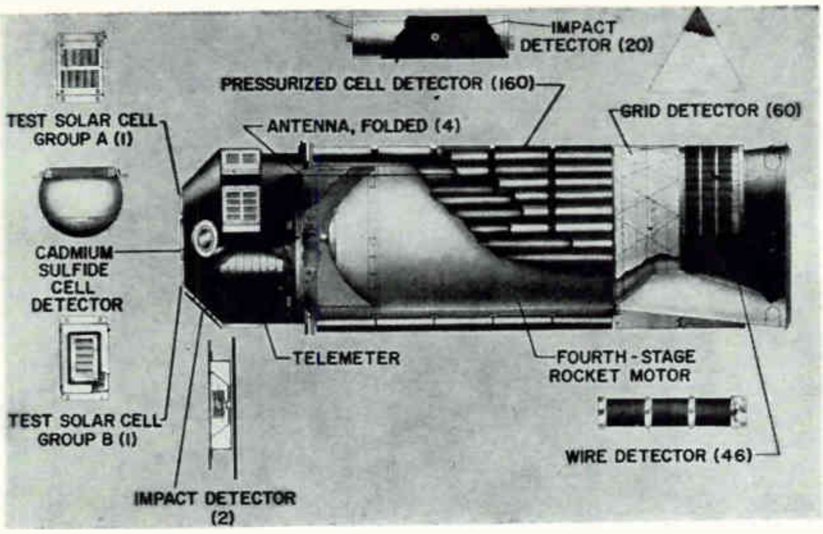
The Rand Corp. and Analytical Services, Inc. are non-profit organizations performing operational analyses, evaluations and other prescribed tasks for Air Force Headquarters.

ARO, Inc., a subsidiary of Sverdrup & Parcel, Inc., runs the Arnold Engineering Development Center in Tenn.; Pan American World Airways and its subcontractor, RCA Service Co., operate the Atlantic Missile Range; Vitro Laboratories maintains and operates the Eglin Gulf Test Range of the Air Proving Ground Center; and Coleman Engineering operates the Hurricane Mesa high speed track facility of the Air Force Flight Test Center.

Flight Simulator for Jet Fighter

Link's aircraft simulator for Navy F8U-2N Crusader drills pilot in instrument flight, normal and emergency action. Instructor can monitor all pilot responses

How Satellite Measures Micrometeoroids



To perform five experiments, the S-55 satellite will carry pressurized cells, foil gages, wire grids, cadmium-sulfide cells and impact detectors

BEFORE YEAR'S END, the National Aeronautics and Space Administration will launch a second micrometeoroid satellite (S-55) to do the job the first one failed to do when it was unsuccessfully launched this summer.

The satellite was designed to send back information about micrometeoroids 240 mi to 620 mi above the earth.

The cylindrical satellite is about 24 inches in diameter and 76 inches long. It is installed around the 18-in. diameter, 72-in.-long Altair rocket motor—fourth stage of the Scout launch vehicle.

The 187.23-lb satellite will give a direct measure of the puncture hazard of micrometeoroids in spacecraft structural skin samples and will measure micrometeoroid flux rates. In addition, the satellite will provide data on the erosion of spacecraft materials by small particles, and will record information for the design of solar cells for spacecraft power through a comparison of measurements obtained from protected and unprotected solar cells.

Five micrometeoroid detectors include pressurized cells, foil gages, and wire grids (providing 24¼ sq ft of area exposed to the penetration hazard), cadmium-sulfide cells and impact sensors (which will have a combined total of 4½ sq ft exposed for impact detection).

Five test groups of window-like silicon solar cells on the nose of the satellite will determine what protection solar cells in future space experiments will require. Five cells are shingled for each group: two groups will be unprotected, two groups will have 6-mil glass slides covering the sensitive area, and one group will have a 62-mil quartz window protecting it.

A series of temperature measurements at selected places throughout the satellite will give additional data. A telemeter system with erectable antennas will be located in the nose section to transmit data to ground receiving stations.

Pressurized cells: these beryllium copper detectors, the primary sensors of the experiment, include 160 half-cylinders ranging in thickness from one-thousandth to five-thousandths of an inch. The 2-inch-wide flat area of each of the 7¼-inch-long half cylinders is mounted in five rows of 32 cells each around the circular exterior of the Altair rocket motor, leaving the can-like cylindrical portion exposed to micrometeoroids.

The cells occupy about a 38-inch-long section of peripheral space in the center of the satellite. The exposed cells will be pressurized with nitrogen and helium so that a puncture will allow pressure to leak out. By a pressure-activated switch in the end of each cell, the pressure loss will be detected and telemetered.

Sixty foil gage detectors, each an equilateral triangle with a 4.57 inch base, are installed around the forward usable half of the fourth stage launch vehicle support structure. Each detector consists of a circuit obtained by an electrochemical deposition process, about 90 microinches thick attached to one-mil Mylar and mounted on the underside of 304-stainless steel skin samples—with 48 of the skin samples being 3-mil thick and 12 of 6-mil thickness. When the stainless steel samples are penetrated, the foil circuits are broken causing a change in the resistance level of the circuit.

Wire grids are similar to sensors flown on previous satellites.

Two cadmium-sulfide cells will be mounted in the nose cone of the satellite about 180 degrees apart. Each cell is mounted in an aluminized glass flask. The six sq in of exposed surface provided by the two detectors are covered with a sheet of quarter-mil Mylar coated with evaporated aluminum on both sides. On penetration, light will focus on the cells, changing resistance.

Impact detectors: piezoelectric crystal impact detecting transducers, acoustically decoupled from the satellite structure, are mounted on sounding boards loaded on the nose cone.

Communication with the satellite will be on two frequencies: 136.860 Mc and 136.200 Mc.

MIT Instrument Lab First On Apollo Team

FIRST MEMBER of Project Apollo team selected by NASA is Instrumentation Laboratory of MIT, which will design guidance and navigation system.

Apollo space vehicle will carry three men to the moon and back, NASA hopes to have it ready for flight in about five to seven years.

MIT will receive $4 million for first year's work. Inertial guidance systems conceived at MIT are in Thor, Titan and Polaris. But the lab is leaning toward celestial fixes for Apollo navigation.

Tv Receiver Market Outstrips Production

TELEVISION RECEIVER sales this year will top 6.2 million units, according to the Electronic Industries Association. In 1960, consumers bought 5,708,346 sets. The 1961 forecast was made in a report to the EIA Consumer Products Division, by Frank W. Mansfield, chairman of the Association's marketing data policy committee.

Manufacturer, distributor and dealer inventories are now at one of the lowest levels in the last six years. Mansfield said that inventories are much too low to support future demands for sets.

Total manufacture, distributor and dealer inventories were at 1.7 million through May of this year. The rate of sales for April and May has exceeded the total inventory figure.

"This means that monthly production, which through May averaged only 435,000 sets, must average 680,000 sets per month for the rest of the year," said Mansfield.

Television Intercoms

Motorola reports that audio-visual intercoms like the prototype units shown above could be produced for about $500. Each Visicom unit contains a tv camera. They could be used as baby sitters, hospital patient monitors and for remote look-see conferences

New Firms Find Capital

By THOMAS EMMA,
Associate Editor

MULTIMILLION-DOLLAR POOL of new venture capital has become available recently to young, expanding electronics firms because of the rapid increase in number and capitalization of U. S.-licensed small business investment companies (SBICs). SBICs operate under highly favorable tax regulations which tend to encourage their investment in newer firms.

A year and a half ago, there was only one SBIC specializing in electronics and related fields. Now there are at least 13 specializing in our industry (there are some 300 SBICs in all fields). Total initial capitalization of the 13 is more than $29 million (see table). The total is being swelled rapidly by public stock offers, a trend which experts in the field expect to continue.

Electronics Capital Corp., for example, has committed investment of more than $14 million of its original $18 million capital. ECC plans to nearly double its capital with a 600,000-share issue. Present shareholders will be offered one new share for each share now held. Minnesota Scientific, one of the newest SBICs, is swelling its capital to over $2 million with a public offering made just last month.

Officers of SBICs and the federal Small Business Administration indicated a number of other trends. Continuing interest of the stock-buying public is seen as a good omen. The rise in SBICs has occurred during a period financially favorable to the electronics industry. As more electronics-oriented SBICs mature, competition for investment opportunities will probably increase.

There may be some further changes in SBIC relations. The Small Business Investment Act of 1958 has been liberalized in the past 18 months. Included in recent favorable legislation are provisions allowing:

TYPICAL ELECTRONICS-ORIENTED SMALL-BUSINESS INVESTMENT COMPANIES

Company	Date Licensed	Initial Capital	Public Stocks
Electronics Capital Corp., San Diego	June 1959	$18,000,000	Yes
Avionics Investing Corp., Washington, D. C.	April 1960	305,000	No
Techno-Fund, Inc., Columbus, Ohio	April 1960	303,000	Yes
Small Bus. Electronics Invstmt., New York	Sept. 1960	303,000	No
Electro-Science Investors, Richardson, Texas	Oct. 1960	7,280,000	Yes
Weston Electronics Investmt., Weston, Mass	Feb. 1961	301,400	No
Electrical Equities, Dallas	April 1961	306,000	No
Capital Dynamics Corp., Los Angeles	June 1961	305,000	No
Capital For Technical Industries, Los Angeles	June 1961	518,400	Yes
Dynamic Capital Corp., Boston	June 1961	305,000	No
Mercury Capital Corp., New York	June 1961	300,000	No
Minnesota Scientific, Minneapolis	June 1961	500,000	Yes
Science Capital Corp., Philadelphia	June 1961	303,500	Yes

In SBICs

• SBICs not publicly owned to issue stock in payment for services and tangible assets

• SBICs not publicly owned to grant stock options as salary

• SBICs to provide capital to small concerns by buying any class of stocks or bonds rather than only convertible debentures.

Tax advantages of SBICs over nongovernment-licensed investment companies are considerable. For example an investment company not licensed by the Small Business Administration (SBA) pays 27½ percent taxes on profits to $200,000 a year and pays 38½ percent on profits above $200,000. SBICs are given complete exemption on all profits reinvested. SBICs are also completely exempt from dividend taxes. Any losses they incur through investment may be deducted against income for tax purposes.

While these changes have helped stimulate formation of SBICs specializing in all types of businesses, an SBA spokesman reports that there are more licensed investment firms in electronics than any other category. Retail grocery specialists run second.

Phil David Fine, SBA deputy administrator in charge of the Investment division, explains: "Men with ideas in a growth industry usually need financing to convert the ideas into successful products. Nowhere in our present economy are there more opportunities for profitable venture financing than in the electronics and allied industries."

According to Casper M. Bower, Minnesota Scientific president, public interest in SBIC stock continues high, bolstered as they are by general interest in electronics and the implications of government control.

SBIC stocks, he said, historically resemble investment trust shares. SBIC investment portfolios cannot usually be priced by open market quotations nor the customary investment analysis yardsticks.

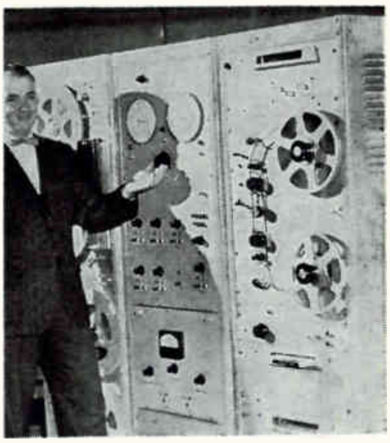
"The reason for this," Bower said, "is that SBIC holdings at this stage generally represent immature or independently-owned companies."

New Gear Automates Broadcasts

Automatic radio station equipment market could run to some $5 million a year according to predictions given this week to ELECTRONICS.

A good chunk of this will be going into magnetic tape equipment, with sensing gear, specialized oscillators and other electronic components following closely.

According to Rogan Jones, president of International Good Music, Inc., Bellingham, Wash., who makes the prediction, the brightest future for automated radio lies in the a-m field because the 3,600 a-m stations now operating outnumber the 1,777 f-m installations. Jones forecasts that 1,000 stations will automate within the next two years. To date, his company has automated some 40 stations.



Equipment like this allows radio stations to air 18 hours of programming without touching a phonograph record

Among the latest to go to automatic operation is station WHOM in New York, which installed its equipment this month. For an initial investment of about $6,000 and a program cost roughly equivalent to the salary of a record announcer, the station is able to air 18 hours of music programming without turning a phonograph record.

Cornerstone of the operation is prerecorded broadcast tape made from commercial records and containing commentary and continuity dialog. Backing up the prerecorded tapes are station-prepared voice tapes. Recorded on the music tape is a 20-cycle, one-second tone at appropriate intervals. This is a switching signal between the 5,000-ft full track music tape and the locally recorded tape. The same type of tone signal is placed on the local tape for two-way switching. The commercial tape plays at 7.5 ips, the local at 7.5 or 3.75 ips.

The tone signalling method is also used to cue in a fresh music tape machine after completion of the two-hour run of the first one.

Controlling the IGM system is a newly-designed four-channel switcher containing sensing equipment—a bridged-T oscillator which listens across the program bus and develops contacts when triggered by the taped tone signals—and a makeup tone generator allowing the station to fade control tone in and out of the commercial tape without a click. Three tape decks are used.

A more complex switching unit is now being tested in three different a-m stations on the West Coast. This is an eight channel system with optional reel-to-reel or sequential cartridge operation. In its full development with all optional equipment the system can automatically play the music, identify the station, play commercial announcements and regulate their number, give the time of day plus weather and news reports and log transmitter readings and commercials. The cost ranges from $7,000 to $12,000 depending on the amount of optional equipment.

The automatic transmitter logging unit is made by Telectronik, Pasadena, Calif. It can sample all readings every ten minutes and record them on paper tape. It can also turn on an alarm if current levels are not correct. Developers are hopeful that Federal Communications Commission approval of automatic logging will come about in the near future.

An automatic program logging system by Westrex logs all programming except music on ¼-in. magnetic tape and stamps the time and date. One tape handles 18 hours of operation. The company is also producing a 50-cartridge tape unit for sequential playing of locally recorded programming.

MEETINGS AHEAD

Aug. 28-Sept. 1: Heat Transfer Conf., International; Univ. of Colorado, Boulder, Colo.

Aug. 30-Sept. 1: Semiconductor Conf., AIME; Ambassador Hotel, Los Angeles.

Sept. 4-9: Analog Computation, International Conf., International Assoc., for Analog Comp., and Yugoslav Nat. Comm. for ETAN; Belgrade, Yugoslavia.

Sept. 6-8: Computing Machinery, National Conf., ACM; Statler-Hilton Hotel, Los Angeles.

Sept. 6-8: Nuclear Instrumentation Symposium, PGNS of IRE, AIEE, ISA; N.C. State College, Raleigh, N.C.

Sept. 6-8: Space Elec. & Telemetry, PGSET of IRE; Univ. of New Mexico, Albuquerque, N.M.

Sept. 6-13: Electrical Engineering Education, Internat, Conf., ASEE, AIEE, PGE of IRE; Sagamore Conf. Center, Syracuse Univ., Adirondacks, N.Y.

Sept. 8-10: High-Fidelity and Home Entertainment Show, Chicago, Crystal Ballroom, Palmer House, Chicago.

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

Sept. 13-15: Photomultiplier Tube Symp. EMI House, Manchester, W.I. London.

Sept. 14-15: Technical-Scientific Communications, PGEWS of IRE, Bellevue-Stratford Hotel, Philadelphia.

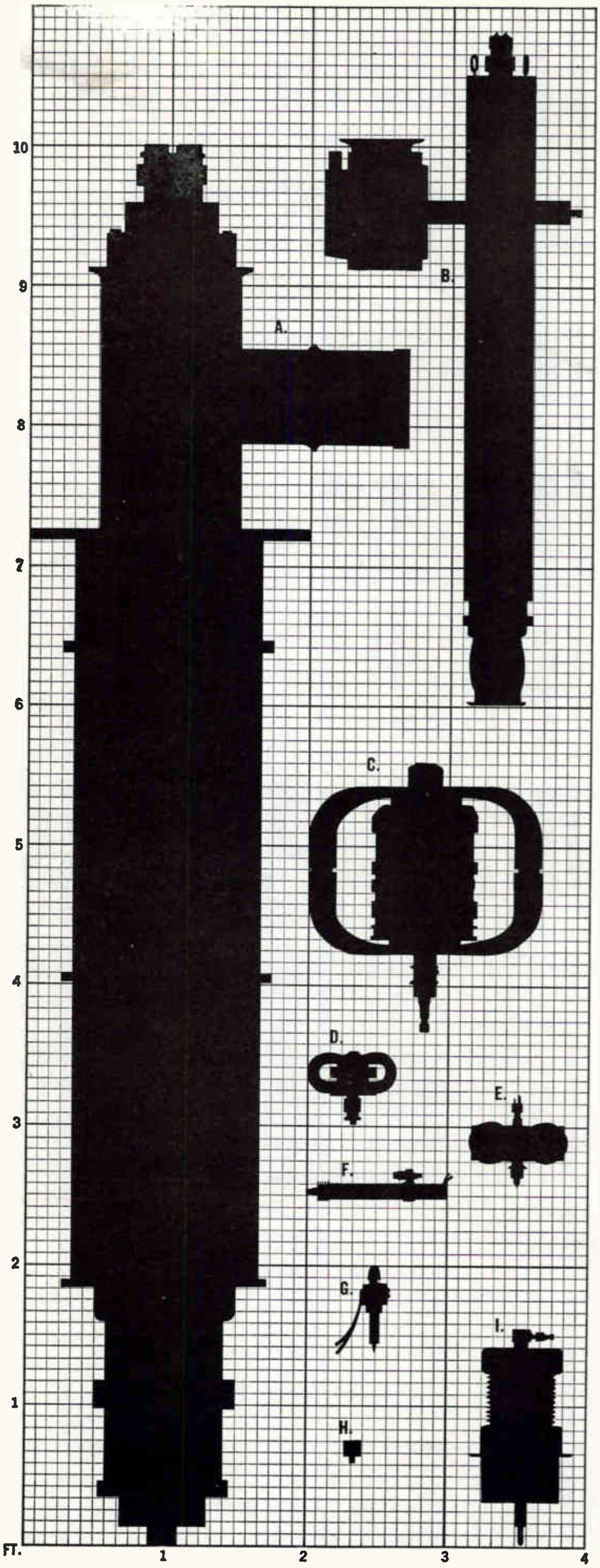
Sept. 14-15: Engineering Management Conf., IRE, Hotel, Roosevelt, N.Y.C.

Sept. 14-25: Federation Nationale des Industries Electroniques Francaises; Parc des Expositions, Paris.

Sept. 20-21: Industrial Electronics Symposium, PGIE of IRE, AIEE; Bradford Hotel, Boston, Mass.

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.



ONE METER TO FOUR MILLIMETERS

New Litton Electron Tubes for Advanced Applications

A. L-3403 KLYSTRON TUBE: One of our super power pulse klystrons for use in long range space radar detection and tracking.

B. L-3270 BROADBAND KLYSTRON: A 2 megawatt L-band klystron offering long life, high peak power, 8 percent bandwidth. Other broadband klystrons, using the exclusive Litton Skirtron techniques, are available with higher power in the L through S-band region with .002-.004 duty cycles.

C. L-3455 HIGH POWER MAGNETRON: A new magnetron delivering a minimum of 2 megawatts peak power at 406-450 mc. with a .002 duty cycle.

D. L-3458 HIGH TEMPERATURE PULSE MAGNETRON: Provides long life operation at ambient temperatures in excess of 662°F. Many hours of 900°F. operation have been achieved in X-band tests.

E. L-3629 FLOATING DRIFT TUBE KLYSTRON: High power, water-cooled klystron oscillator fixed tuned at 33,000-37,000 mc. Power output: 15 watts CW minimum. Other tubes available for immediate delivery from 12-4 mm. wavelength.

F. L-3472 TWT: PPM focused traveling wave tube offers higher CW power — 10 watts minimum — and wider bandwidth in a compact 3-lb. size. Operates in the range of 7,000-11,000 mc. One of a line of TWT's including a 1000-watt X-band pulse tube.

G. MICROTRON: The L-3189, one-kilowatt CW magnetron, is accompanied in package form by an electromagnet and filter assembly, high voltage and filament and isolation transformers. Only 6-second warm-up. Two year warranty for domestic microwave cooking.

H. L-3430 CUBE MINIATURE MAGNETRON: A one-kilowatt miniature magnetron, fixed tuned at 9300 ± 30 mc, weighing less than 9 ounces and no bigger than a normal X-band waveguide flange. Developments at other power levels and frequencies are planned.

I. L-3408 SWITCH TUBE: Provides switching at relatively low control voltage levels with an efficiency of 95 percent. Features high voltage holdoff, high current handling. Collector ratings: 150 Kv; 20 Amps; 10 KW dissipation.

For information on our tube line, exclusive of classified types, send for the 1961 Electron Tube Condensed Catalog. Write to: Marketing Dept., Electron Tube Division, 960 Industrial Road, San Carlos, California

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MICROWAVE TUBES AND DISPLAY DEVICES

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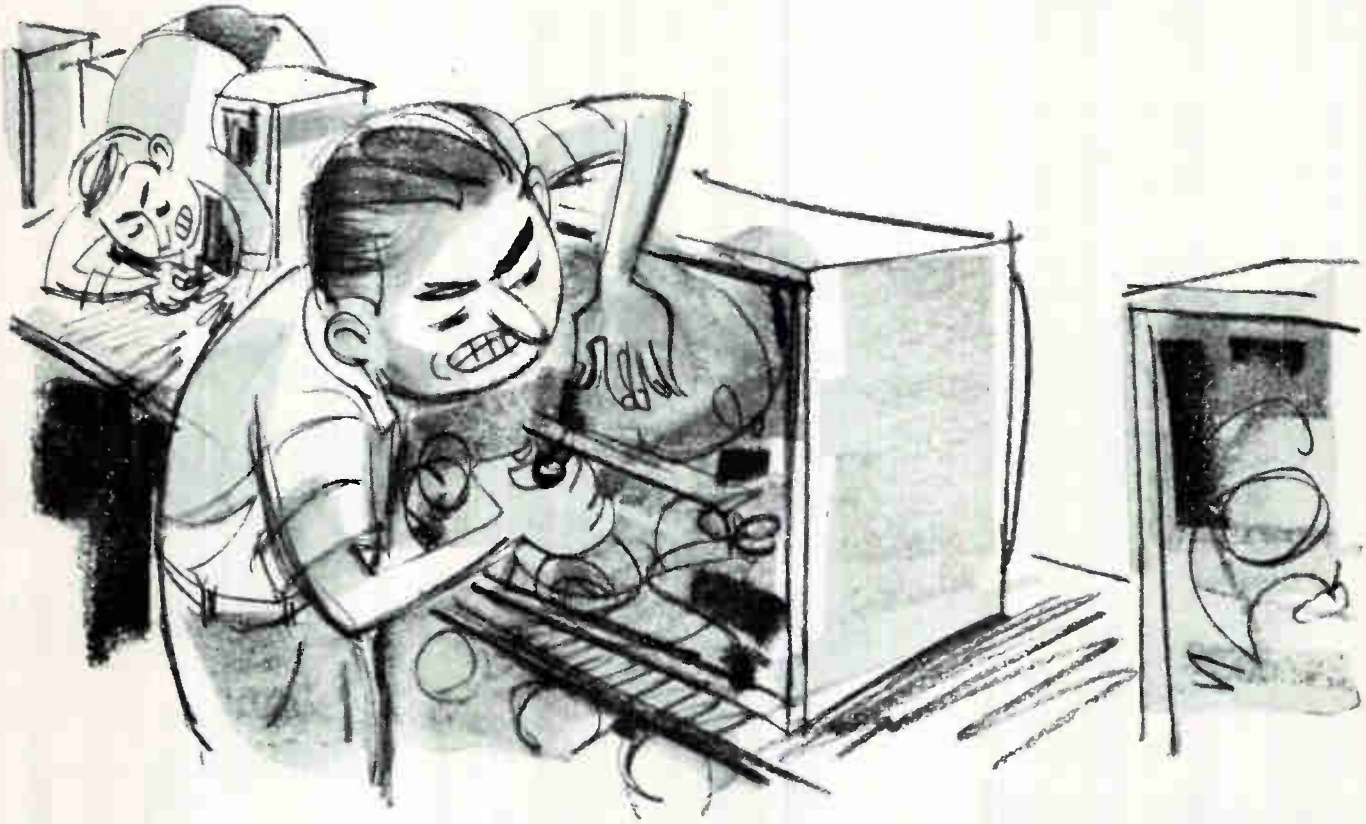
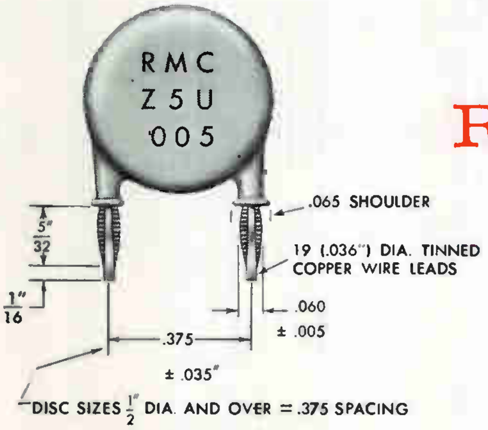
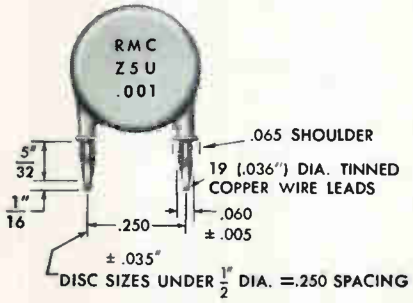






RMC Fin-Lock DISCAPS

The unique design of RMC Fin-Lock leads eliminates lead crimping in assembly line operations. Designed for holes from .053 to .060 Fin-Lock leads are stopped in holes over .060 by the exclusive shoulder construction. These leads permit either automatic or hand assembly with assured stand up positioning.

Fin-Lock leads are available on all RMC DISCAPS of standard voltages, ratings and spacings.

DISCAP CERAMIC CAPACITORS

RMC

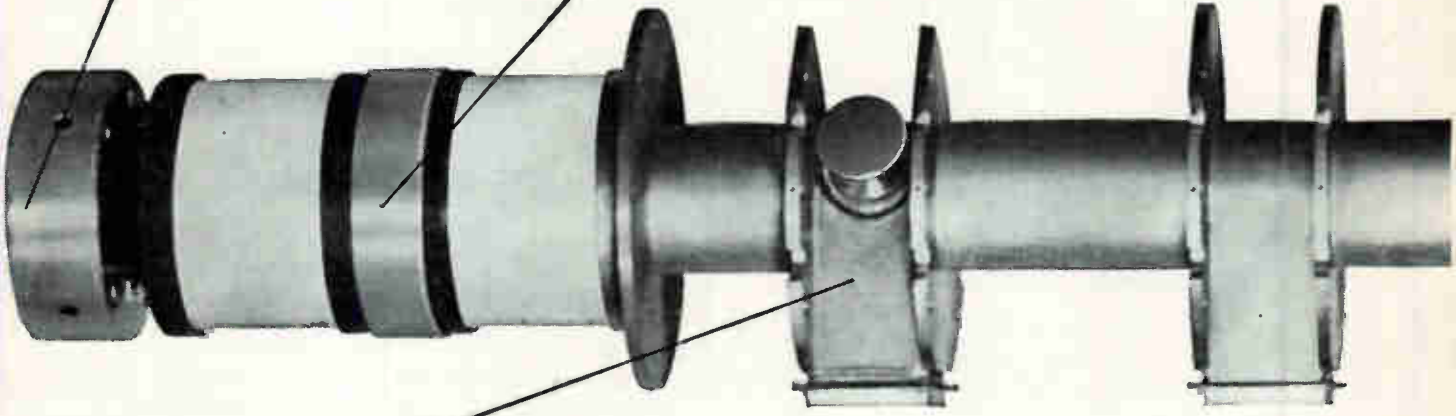
RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

CIRCLE 33 ON READER SERVICE CARD

HOW TO BUILD THE PERFECT KLYSTRON:

1. Perfect a highly convergent electron gun that will confine electron flow so that your klystron will be stable and have the longest life possible. (Only Eimac has done it—with the Heil gun.)

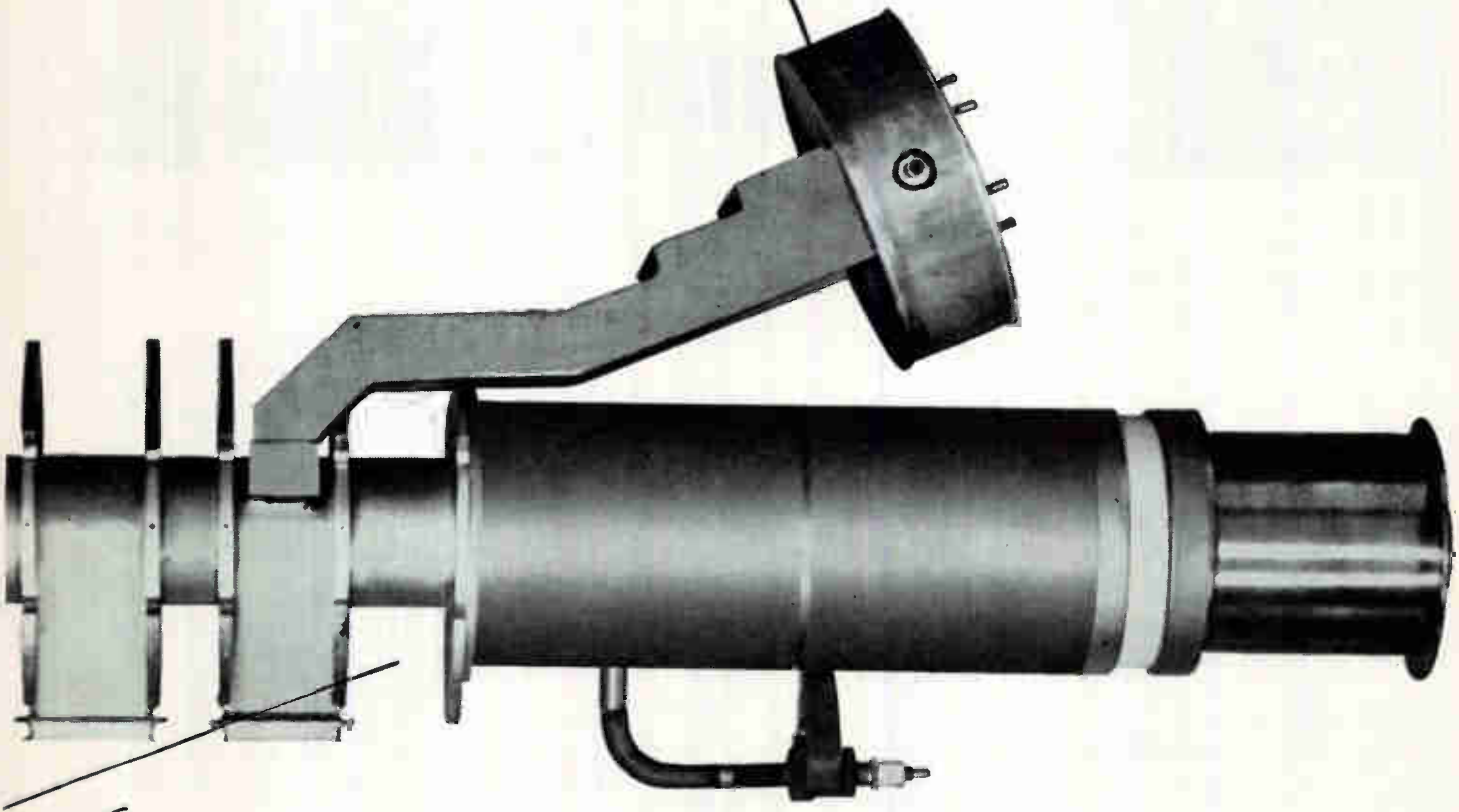
2. Devise a modulating anode that will slash the power required to precisely control the klystron beam. (Eimac's already done it . . . making super power radar practical.)



4. Design your klystron with either an internal, an external, or a combined internal-external cavity to meet all power and frequency needs. (Only Eimac is able to do it today.)

5. Build and put into successful pulse and CW service more than three thousand high-power klystrons to prove your ideas. (Eimac's already done it . . . with more klystrons than any other manufacturer.)

3. *Take ten years or more to perfect advanced materials processing techniques including fifty foolproof metal-ceramic seals and the first output windows made with BeO—to give yourself plenty of design freedom. (Eimac's already done it.)*



6. *Do your work in the world's most complete tube development and production facility, one that includes a DC power supply twice as big as any other. (That's Eimac . . . where the new power supply provides 325 KV at ten amps D.C.)*

7. Short Cut: *Just bring your power and frequency needs to Eimac and get your "perfect" klystron fast . . . from the factory* or *the development lab. Test our reaction time by writing or phoning: Power Klystron Marketing, Eitel-McCullough, Inc., San Carlos, California.*

Eimac

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If tomorrow every syndicated cartoon, column and ad in which AIR EXPRESS played a part were missing from your morning paper, you'd know it instantly. The graphic arts, printing, publishing and advertising industries rank high among AIR EXPRESS users. Their engravers' plates, photos and illustrations—even entire newspapers—get top priority on all 10,000 daily scheduled U.S. airlines flights—first on, first off, first there. And they get door-to-door pickup and delivery, too, by a special 13,000-truck fleet—plus kid-glove handling. And just one phone call arranges everything, at amazingly low cost. So always . . . think AIR EXPRESS first!

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CIRCLE 37 ON READER SERVICE CARD

Fluidized Bed Coating . . . A Progress Report

After six years of intensive research and development, the WHIRLCLAD* Coating System, using a fluidized bed of dry powder, has become a commercially feasible and economical process now fully adapted to volume production. The Polymer Corporation, through its WHIRLCLAD Systems Engineering facilities, has helped more than 100 manufacturers achieve volume production quickly and efficiently.

Q. What types of companies are using the WHIRLCLAD Coating System?

A. Both large and small companies in many different fields of industry. Typical companies are: Allis-Chalmers, Barber-Colman, General Electric, General Motors, Globe Industries, International Harvester, Jones & Laughlin, Kuhlman Electric, Leland Airborne Products, McGraw-Edison, RT&E Corp., Rockwell Manufacturing, Rotron, Uptegraff, Wagner Electric, Westinghouse and many others.

Q. Why is the WHIRLCLAD Coating System used?

A. It offers important product advantages and fabricating economies compared with other coating methods. One quick dip in a fluidized bed of dry powder forms a uniform coating free of sags or bridging. Experience has proven that a correctly-engineered WHIRLCLAD system is highly reliable; there are virtually no interruptions in production of the type that plague liquid process finishing systems.

Q. How does Polymer help manufacturers start using the WHIRLCLAD system?

A. Polymer's Systems Engineering Group is available to manufacturers for the design of efficient and economical coating systems and for establishing detailed specification of the components and equipment required. It also offers the facilities and experience of the WHIRLCLAD Development Laboratory to evaluate materials and develop techniques for economical operation. This service can draw upon a pool of knowledge which has taken six years and over $2 million to develop. Techniques are steadily improved by continuing research.

Q. What is the WHIRLCLAD patent position?

A. Polymer Processes, Inc., a subsidiary of The Polymer Corporation, controls five issued U.S. Patents covering various aspects of the fluidized bed coating process (four of the five have issued in 1961). Over 40 additional patent applications are pending. Polymer Processes also has a licensing agreement with the right to sublicense covering patents and technical developments with Knapsack-Griesheim, a division of one of Germany's largest chemical companies, where this unique coating system was first developed.

Q. How are WHIRLCLAD licenses obtained?

A. They are available in either of two forms which meet most requirements. Both are free of down payments or minimum annual fees. In the simpler form, royalties are included in the cost of coating materials supplied by Polymer or other authorized sources. The second contract provides long-term guarantees for users considering major investments in equipment.

Q. Will licenses be available from sources other than Polymer Processes?

A. Yes. Polymer is instituting a program of education and technical assistance with a selected group of equipment manufacturers and coating material producers who will be able to issue licenses to their customers.

Q. How much are royalties?

A. Royalties are 5% of the cost of materials used in the patented process. This amounts to a negligible percentage of the sale price of finished articles—the customary basis for royalty calculation.

Q. Where can I get more information?

A. Technical literature; illustrated brochures of equipment, materials and methods; data sheets on tests and field performance—the results of years of research and development—are available on request through Polymer Processes. This group also evaluates equipment, handles licensing arrangements, and offers Systems Engineering Service to customers installing major coating lines. Special equipment, unique to the WHIRLCLAD System and not generally available elsewhere, is also sold through Polymer Processes. For more information, we suggest you contact us at your earliest convenience.

*TM Polymer Processes, Inc.

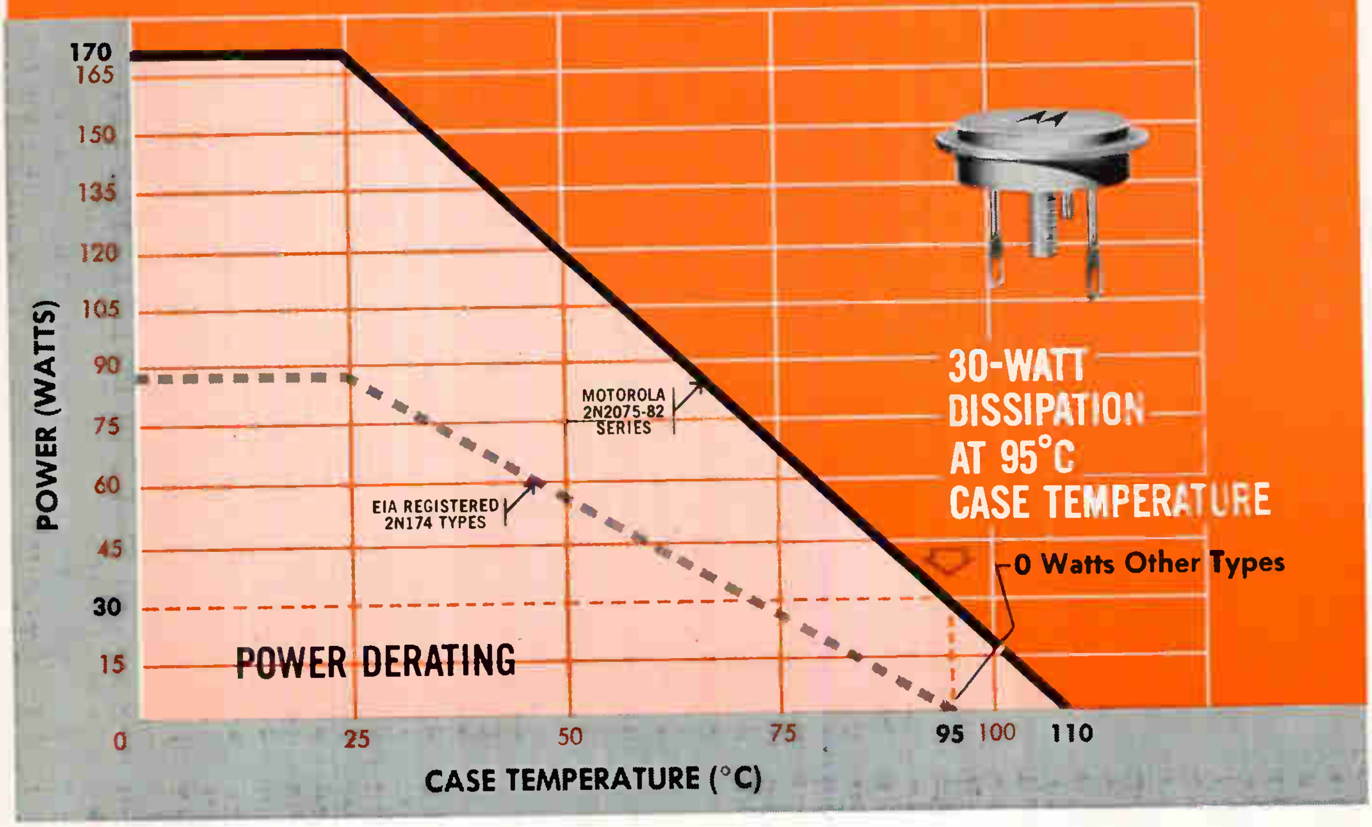
POLYPENCO®

POLYMER PROCESSES, INC.

A Subsidiary of The Polymer Corporation

Reading, Pennsylvania

NEW MOTOROLA GERMANIUM POWER TRANSISTORS OPERATE UP TO 110°C... DISSIPATE 70 WATTS AT 75°C CASE TEMP.



New Motorola germanium power transistors provide superior extended performance to 110°C maximum junction temperature. The 2N2075 series, with 0.5°C/W thermal resistance, now gives you devices capable of up to 170 watts power dissipation . . . offer practical operation far beyond the limits of old-style units. And with 20 in.-lbs. maximum stud torque — almost double that previously offered — these superior Motorola 2N2075 series devices in low-silhouette TO-36 packages can be tightened more firmly to the chassis for better unit-to-heat sink contact and cooler operation.

The new series is also available in Motorola "Meg-A-Life" "A" versions with life test data for greater assurance of reliability. Under the new, even more stringent Meg-A-Life program for power transistors, life testing is extended to 110°C, and the program significantly tightens up the allowable change in gain. In addition, for extra convenience to design engineers, Motorola data sheets for this series with extended specifications show safe operating areas, typical I_{CBO} vs. temperature curves, low voltage output characteristics curves, peak pulse power derating curve, and other useful design information.

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For your copy of data sheets on Motorola's new power transistor series, contact your Motorola district office, or write: Motorola Semiconductor Products, Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

UNIT NO.	h_{FE}	BV_{CES}	UNIT NO.	h_{FE}	BV_{CES}
2N2075	20-40	80 V	2N2079	35-70	80 V
2N2076	20-40	70 V	2N2080	35-70	70 V
2N2077	20-40	50 V	2N2081	35-70	50 V
2N2078	20-40	40 V	2N2082	35-70	40 V

NOTE: The following specs are available to all units above:

Maximum Junction Temperature +110°C
Electronics Industries Association Registered θ_{jc} Maximum 0.5°C/W
Resulting P_c Maximum 170 W
Maximum Stud Torque 20 inch-pounds

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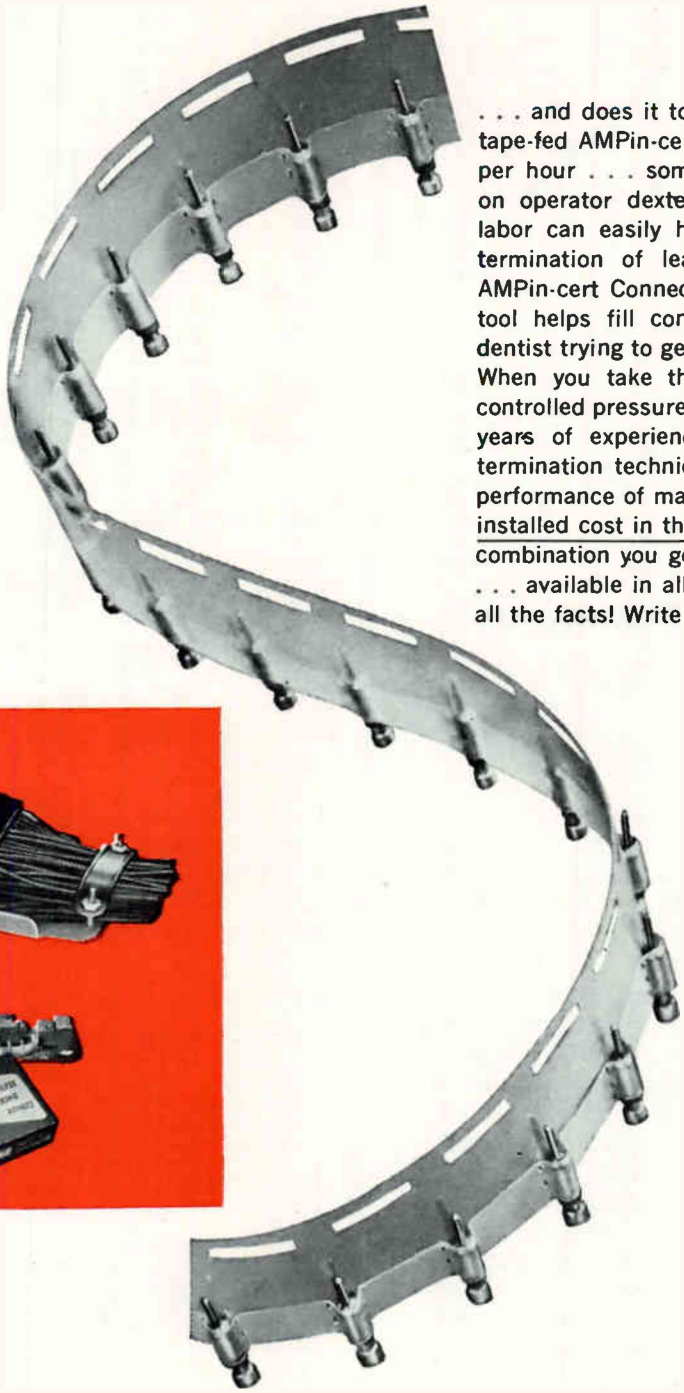
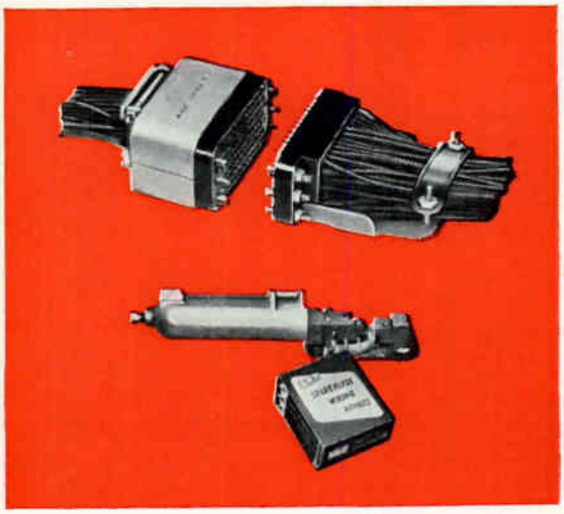
CIRCLE 39 ON READER SERVICE CARD

THIS TAPE PLAYS BACK THE SOUND OF MONEY...



. . . and does it to the tune of more than 1,600 tape-fed AMPin-cert Pin and Socket terminations per hour . . . sometimes even more, depending on operator dexterity! Lower cost, semi-skilled labor can easily handle not only the automatic termination of leads but also the loading of AMPin-cert Connector blocks. A simple insertion tool helps fill connector cavities faster than a dentist trying to get away for an afternoon of golf. When you take these advantages and add the controlled pressure crimp backed by AMP's twenty years of experience in the field of solderless termination techniques . . . you have connector performance of maximum reliability at the lowest installed cost in the industry. This is the winning combination you get with AMPin-cert Connectors . . . available in all sizes and configurations. Get all the facts! Write today!



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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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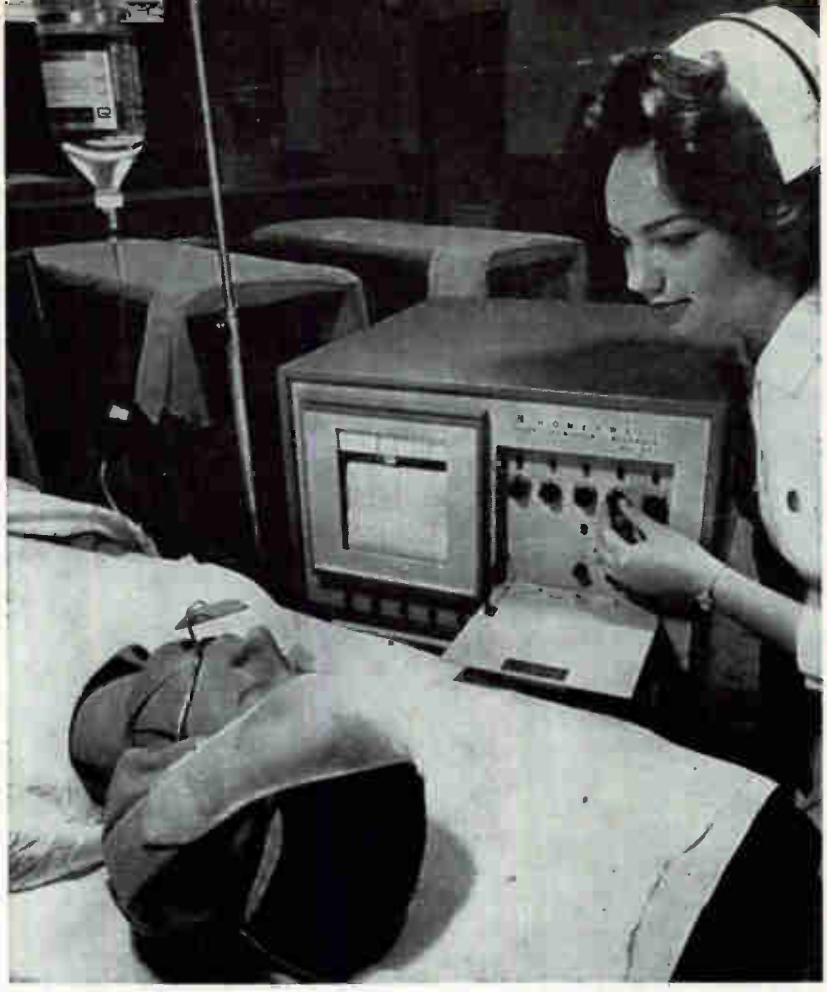
electronics
August 25, 1961

International conclave attracts speakers from fifteen countries. Computer applications dominate discussions, but virtually all areas are covered by 299-paper program

By WILLIAM E. BUSHOR,
Associate Editor



Nurse adjusts recorder-alarm controls of Minneapolis-Honeywell's body function monitor demonstrated at conference. Unit automatically measures and records temperature, pulse rate, respiration rate, and diastolic and systolic blood pressure of post-operative patient

Review of World-Wide Progress in MEDICAL ELECTRONICS

COMMON ENEMIES of mankind—disease, illness and infirmity—were attacked on a broad scale last month by the nations of the world. Their weapon was electronics. The occasion was the joint convention of the 4th International Conference on Medical Electronics and the 14th Annual Conference on Electrical Techniques in Medicine and Biology, hosted for the first time by the U. S.

Out of the 299 papers given, 25 percent were from 15 countries other than the U. S. One of the papers described a simple analog computer at Rockefeller institute in which information on disease symptoms is stored for later matching against the symptom record of an individual patient.[1] Film is the storage medium. Characteristics of each disease and the significance of each symptom are recorded as a spectrum of lines of varying densities. Correlation of symptoms for a patient against possible diseases is obtained by matching the spectrum of all diseases against the spectrum for the patient's disease symptoms. This matching can be evaluated by determining the amount of light passing through the matched lines.

Pattern recognition of an electrocardiogram (ecg) using computer techniques is being done by Airborne Instruments Laboratory with the U. S. Public Health Service.[2]

A report on the use of a computer to determine fetal heart rate by autocorrelation was given by the Department of the Army.[3] Abdominal leads are applied conventionally and the ecg signal recorded on a two-channel recorder to obtain good maternal and fetal heart beat recording. The electrodes are then moved close together and amplifier gain increased until the fetal signal is completely lost in random noise and the maternal signal is barely discernable. A five-second

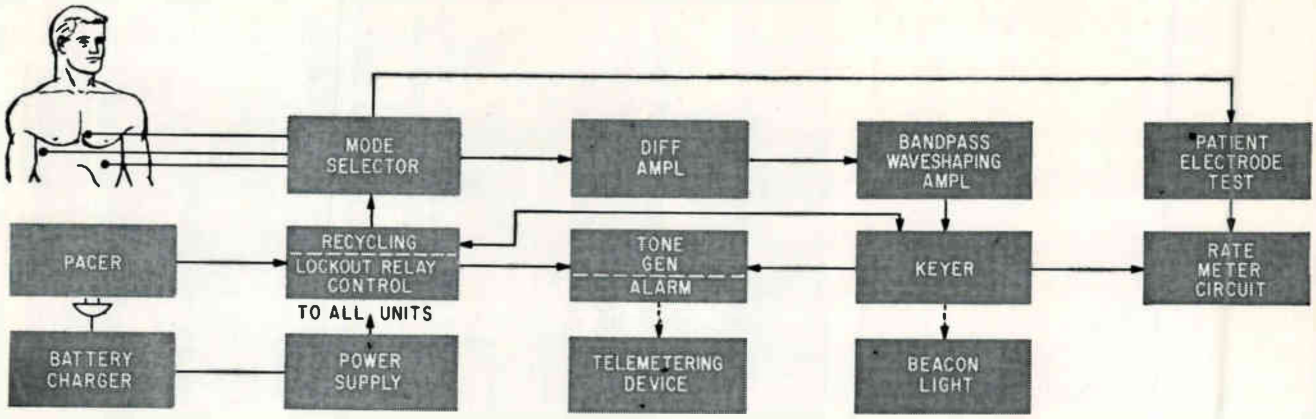


FIG. 1—Automatic cardiac monitor-pacer developed at U. of Maryland. In addition to audible alarm, a red beacon lamp can be attached to permit distant visual monitoring

sample of the recording is then taken at 996 equally spaced points and, after being translated to punched cards, this data is used as input to a computer. In this manner the average fetal heart rate during the brief sampling periods is obtained. The periodicity of the signal is used to enhance it with respect to undesired signals and to separate it from other periodic signals, such as the maternal complex.

A pulse-rate monitor, about the size of a small portable radio, that displays instantaneous pulse rate between pulses as it continuously monitors a subject was described by the SAVE (Service Activities of Volunteer Engineers) group of Chicago.[4] Heart impulses are picked up with two electrodes placed on the chest and amplified by four transistors. The amplified signal is fed to a diode circuit that generates positive pulses triggering a transistor switch. Two relays are actuated by the switch terminating the charge circuit to a capacitor whose total charge is a measure of the time interval between pulses. This terminal voltage is transferred to another capacitor, which biases the grid of a pentode whose plate circuit contains a milliammeter. Thus, the recording on the meter is an indication of time interval between the last two pulses.

Another instantaneous pulse-rate monitor has been developed by researchers at the Gilford Instrument Labs.[5] This device also measures the time interval between pulses to obtain a voltage proportional to the interval. However, upon completion of the measurement, a computer is activated that calculates the reciprocal of the time interval within 5 millisec. This reciprocal controls the on time of an internal clock oscillator that feeds a binary counter having a numerical display.

A heart monitor capable of automatically turning on a cardiac stimulator when the heart beat drops below a preset rate and of switching the stimulator off when the correct rate is reestablished was described by U. of Maryland School of Medicine personnel (Fig. 1).[6] The unit can also be used solely as a monitor or pacer, to continuously telemeter heart impulses and for external or internal cardiac stimulation. The rate can be varied up to 250 beats a minute. The negative-going exponential pulses generated have a maximum amplitude of 250 v with a pulse width of two millisec at ½ power.

A team from the Institute of Muscle Disease and the State University of New York discussed their combination pacemaker-needle device for emergency stimulation of the heart during complete cardiac arrest.[7] The needle inserts the flexible lead electrodes through the chest wall until contact with the heart is made. A transistor pacemaker then provides 5-v, 2.5-millisec stimulus pulses.

A team from the Rockefeller Institute and the Yale School of Medicine have developed a technique for stimulating the heart internally without bringing electrode wires through the chest wall.[8] A resonant-circuit receiver, connected to heart electrodes, is buried under the patient's skin. This circuit is excited externally by a loop taped to the patient's chest and driven by a 2-Mc current source. The implanted receiver contains a pickup coil, capacitor and silicon diode for rectifying the 2-Mc pulses before application to the heart. Full control of pulse amplitude, duration and rate is possible; variable amplitude of up to 40 v peak for rates of 40 to 150 pulses a minute at a fixed duration of 1 millisec can be obtained.

Melpar workers described a cardiac monitor that, when combined with an ecg recorder, can continuously monitor cardiac rhythm for detection and diagnosis of malfunctions.[9] When any of the preset limits is exceeded a warning lamp lights, a remote audio warning is sounded and a 15-second ecg record is made.

An ultrasonic flowmeter operating on the doppler principle has been built at the U. of Wisconsin (see Fig. 2).[10] Because of the doppler effect, a sound wave propagated upstream has a longer round-trip transit time than a sound wave propagated downstream. These transit times are determined by measuring the phase angle between received and transmitted signals, the difference being proportional to flow velocity. Two 1-Mc ferroelectric crystal transducers are used, each serving alternately as a transmitter and receiver. Receive and transmit signals are heterodyned to 10 Kc to ease phase angle measurement problems at the 1-Mc operating frequency.

A servo control system developed at the Karolinska Institute in Sweden follows movements of an endoradiosonde (radio pill) while the pill itself is detecting and transmitting information on intralumi-

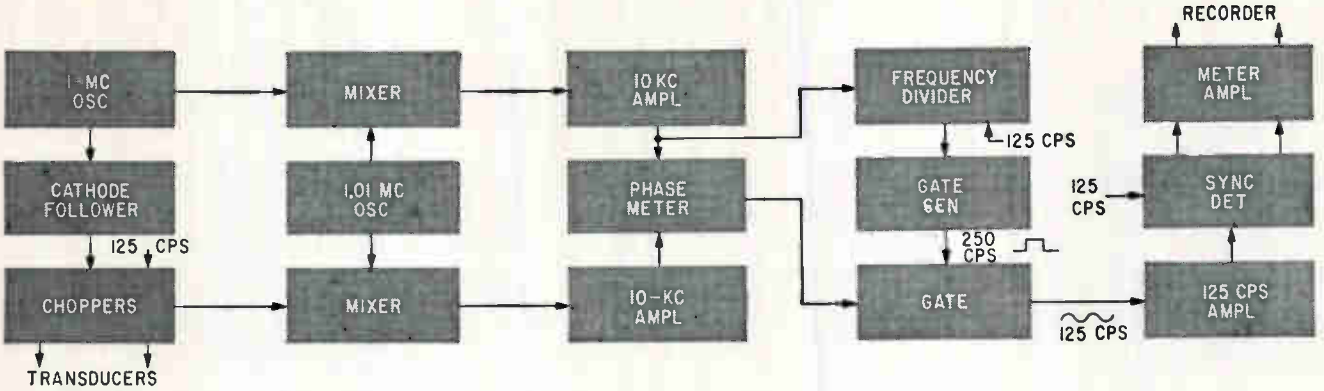


FIG. 2—Ultrasonic flowmeter, built at U. of Wisconsin, uses doppler principle to measure sound wave transit time, which is function of blood flow rate

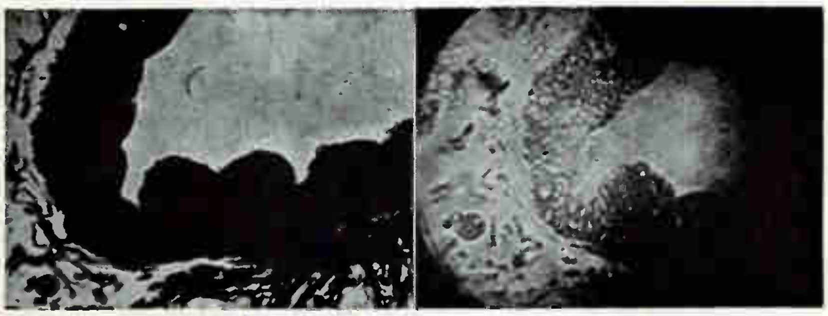
nal pressure variation within the alimentary canal.[11] Pill position is easily and accurately determined by placing a servo-controlled omnidirectional antenna on the patient's stomach. The system automatically tracks the movement of the pill while a pen recorder maps the pill's position. A receiver is used whose avc voltage is a function of the signal strength picked up by the antenna.

Israel's Weizman Institute of Science has devised a subminiature transistor-radio-telemetering electroencephalograph (eeg) system that permits unrestrained movement of the subject.[12] When placed on the subject, the unit amplifies the eeg signal picked up by electrodes on the brain and transmits the data to a remotely located receiver. The amplifier uses four transistors; the 3 to 5-Mc transmitter is a frequency-modulated vhf oscillator that requires only one transistor. Transmission distance of over 10 yards has been obtained with a commercial receiver.

Researchers at GE's Advanced Electronics Center at Cornell U. have found that the human auditory system can respond not only to acoustic energy but also to electromagnetic energy in at least a portion of the r-f spectrum.[13]

Response is instantaneous and occurs at low power densities (below the density that will cause biological damage, that is, 1/30 the standard maximum safe level for continuous exposure). Some experiments were conducted at 1,310 Mc, with a 244 pps pulse rate, a pulse width of 5 microseconds and a duty cycle of 0.0015, others at 2,982 Mc with a 400 pps pulse rate, a pulse width of 1 microsecond and a duty cycle of 0.0004.

These investigators feel the human auditory system responds to frequencies as low as 200 Mc and at least as high as 3,000 Mc. Apparently, perception of r-f sound is induced by acoustic energy external to the eardrum. It also appears that the subject must at least have the ability to hear 5,000 Kc, although not necessarily by air conduction. Temple areas of the head seem to be reception sources. Further work is in progress to determine nature, cause and implications of this effect.



Details of a section of the human iris as seen with visible light microscope (left) and with Nippon Electric's infrared microscope (right)

The U. of Tokyo and Nippon Electric Co. collaborated in developing an infrared microscope sensitive to radiation over a range of 4,000 to 13,000 Angstroms.[14] The instrument consists of a microscope combined with an optical system that includes an image tube and a 16-Kv d-c power supply. A filter placed over the light source provides infrared illumination of the viewed object. The magnified infrared image is focused on a photoelectric surface of the image tube. The visible image is photographed. The instrument can be used to distinguish normal cells from cancer cells, internal structure of bone tissue and details of the iris of the eye (see photo).

REFERENCES

Note: All papers presented at International Conference on Medical Electronics in New York City, July 16-21, 1961.

(1) V. K. Zworykin, A Mechanized Matching Procedure for Computer Aided Differential Diagnosis.

(2) C. A. Steinberg, W. J. Carbery, J. M. McBride and C. A. Caceres, Pattern Recognition in the Electrocardiogram.

(3) A. G. Favret, Autocorrelation Techniques Applied to the Fetal Electrocardiogram.

(4) L. J. Ryan, A Portable Instantaneous Pulse Rate Monitor.

(5) S. R. Gilford and M. Martens, An Instantaneous Reading Cardiotachometer with Digital Display and True Linear Output.

(6) M. Tischler, A. Tamres and R. A. Cowley, Automatic Cardiac Monitor.

(7) S. M. Ross and B. F. Hoffman, A Bipolar Pacemaker for Immediate Treatment of Cardiac Arrest.

(8) L. Eisenberg, A. Mauro and W. Glenn, Transistorized Pacemaker for Remote Stimulation of the Heart by Radio Frequency Stimulator.

(9) B. H. Dennison, The Cardiac Sentry.

(10) W. C. Zarnstorff and C. A. Castillo, An Ultrasonic Flowmeter.

(11) B. Jacobson, Antenna Servo System for Tracking Endoradiosonde Movements.

(12) H. Fischler and E. H. Frei, Subminiature Electroencephalograph for Radio-Telemetering.

(13) A. H. Frey, Human Auditory System Response to Modulated Radio Frequency Energy.

(14) S. Tasaka, T. Sakita, Y. Utsumi, K. Tanaka, E. Kaneko, O. Harashima and A. Ouchi, Infrared Microscope and Its Application to Medical Use.

NEGATIVE-RESISTANCE DIODE

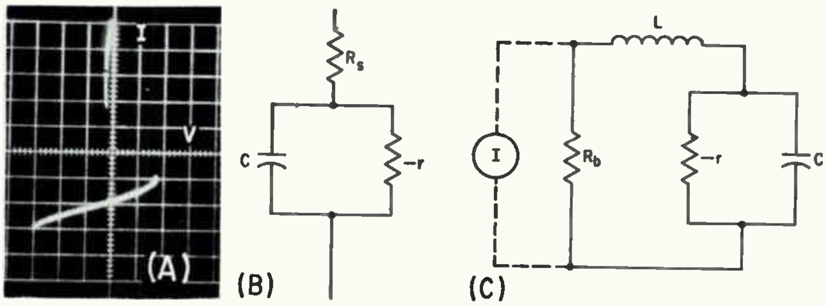


FIG. 1—Bonded NR diode shows an I-V characteristic (A) that is single-valued in the current, at 2 ma per cm and 5 v per cm; equivalent circuit (B) of the diode; and analysis of equivalent circuit (C)

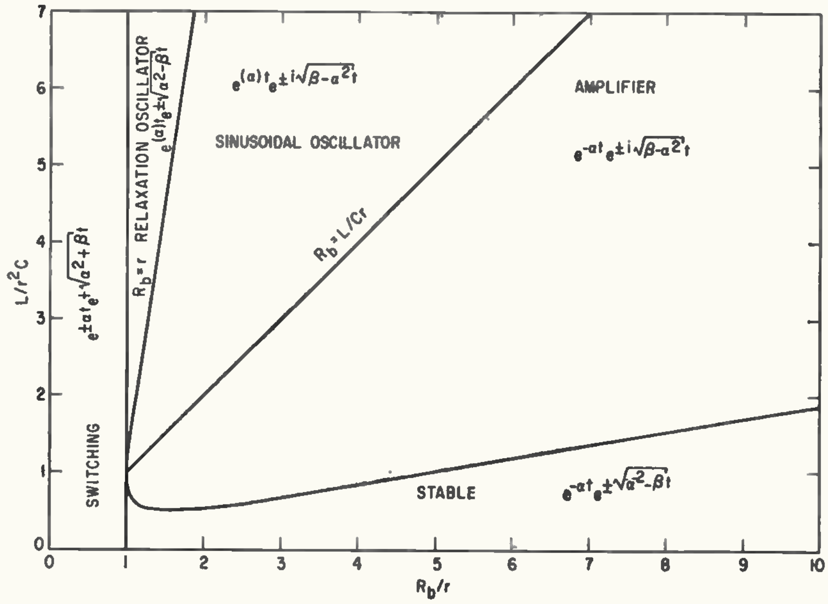


FIG. 2—Parameter relationship of the bonded NR diode circuit

TABLE — BEHAVIOR OF EQUIVALENT CIRCUIT

$$\phi = \exp - \alpha t \times \exp (\alpha^2 - \beta)^{1/2}$$

$\beta > 0$	$e^{-\alpha t}$ Represent	And for	$\exp \pm (\alpha^2 - \beta t)$	Combine to Give	Which Represents	Mode of the Device
$\alpha < 0$	Growing Exponential	$\alpha^2 < \beta$	Sine Waves	$\exp [\lvert\alpha\rvert \pm i (\beta - \alpha^2)^{\frac{1}{2}}]t$	Growing Sine Waves	Sine Wave Oscillator
$\alpha < 0$	Growing Exponential	$\alpha^2 > \beta$	Mixed Exponential	$\exp [\lvert\alpha\rvert \pm (\alpha^2 - \beta)^{\frac{1}{2}}]t$	Damped X Growing Exponential	Relaxation Oscillator
$\alpha > 0$	Damped Exponential	$\alpha^2 < \beta$	Sine Waves	$\exp[-\lvert\alpha\rvert \pm i(\beta - \alpha^2)^{\frac{1}{2}}]t$	Damped Sine Waves	Amplifier
$\alpha > 0$	Damped Exponential	$\alpha^2 > \beta$	Mixed Exponential	$\exp[-\lvert\alpha\rvert \pm (\alpha^2 - \beta)^{\frac{1}{2}}]t$	Damped Exponential	Stable

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TWO of the many ways of achieving negative resistance effects in semiconductor devices are embodied in the Esaki diode and the bonded NR diode.

The well-known Esaki diode is a *p-n* junction device in which the negative resistance arises from a voltage-dependent current due to tunneling between the energy bands of the degenerate (low resistivity) semiconductors that form the junction.

The bonded NR diode is apparently a n^+n junction device in which the negative resistance arises from a combination of avalanche breakdown and conductivity modulation due to the current through the junction. Functionally similar devices have been reported.[1-4]

Conductivity modulation is a change in the effective carrier density in the semiconductor caused by carrier multiplication at the junction, the back contact or elsewhere in the semiconductor material. For this effect to be large, the additional carriers generated by the injected carriers must be a large fraction of the carriers present. Such effects would therefore be expected to be most pronounced in materials of low carrier density (high resistivity).

The bonded NR diode is fabricated by pulse-bonding a doped gold wire into a high-resistivity *n*-type semiconductor. This is easily done and results in a current-controlled negative resistance (Fig. 1A).

This current-controlled behavior results in one attractive feature not usually found in two-terminal devices. That is, in assembling a circuit the input and output circuits may be coupled through the device itself and thus to some degree isolated from one another. This is not possible using Esaki diodes.

The device reactance is somewhat unusual in that it shows strong frequency-dependent effects at low frequencies. No effort has yet been made to utilize these effects in any circuit application. Above frequen-

HANDLES HIGH POWER

cies of four megacycles this reactance is constant, and equivalent to a junction capacity of about 0.4 pf.

The simplest dynamic equivalent circuit of the bonded NR diode consists of a small resistance in series with a parallel combination of a negative resistance and a shunting reactance (Fig. 1B). This reactance is assumed to be capacitive at the frequencies of interest here.

To use the device a bias circuit must be introduced (Fig. 1C). Since the device is current-controlled, it must be biased from a current source. This current source is open-circuited in the usual manner for analysis of the resulting circuit. The solution for charge or current flow through circuits of this type is an exponential function of time: $\phi = Ae^{st}$; A and s here may be complex. The small-signal behavior of the device is assumed to be such that the solutions will approximate a single exponential function. Certainly this is true if the signal amplitude is made small enough. Under this assumption the impedances of the circuit can be written in the form $Z_L = X_L = sL$ for the inductance, and $Z_c = X_c = 1/sC$ for the capacitance.

The admittance of the circuit in Fig. 1C is $Y = 1/R_b - 1/[sL - r/(1 - rsC)]$. Setting this admittance equal to zero, the equation for the zero admittance conditions is obtained in terms of the time coefficient in the exponential function. The resulting equation is $sL - rs^2 LC - r + R_b - R_b sC = 0$. Factoring this gives $s^2 + s(R_b/L - 1/rC) - R_b/rLC + 1/LC$. Solving for s gives $s = -\alpha \pm \sqrt{\alpha^2 - \beta}$ where $\alpha = \frac{1}{2}(R_b/L - 1/rC)$ and $\beta = (1/LC)(R_b/r - 1)$.

The form of the solution for the current flow through the equivalent circuit is then $\phi = A\,(\exp -\alpha t)\,\exp(\pm t\sqrt{\alpha^2 - \beta})$. The behavior of the circuit thus depends upon the relationship between α and β. That is, if $\beta > \alpha^2$, the second exponential function represents sinusoids; if $0 < \beta < \alpha^2$, the second exponential function represents exponentials, growing or damped depending upon the value of α. Obviously $\alpha > 0$ means that the first exponential function is a damping term; $\alpha < 0$ means that the first function is a growing exponential. The combination of these functions represents the behavior of the equivalent circuit. This behavior is summarized in the table. For $\beta < 0$, growing exponentials result, and hence switching in all cases.

The relationships between α, β, and α^2 divide the impedance plane of the circuit parameters into regions in which only one type of behavior occurs. The values of α and β in terms of the device and circuit parameters are:
$\alpha = \frac{1}{2}(R_b/L - 1/rC)$ and $\beta = 1/LC\,(R_b/r - 1)$; where $\beta > 0$ implies $R_b > r$; $\beta < 0$ implies $R_b < r$; $\alpha < 0$ implies $R_b > L/rC$; $\alpha > 0$ implies $R_b < L/rC$.

The above inequalities define two straight lines in the impedance plane of the circuit parameters. The expression which results from the relation between α^2 and β is more complicated.

$$\alpha^2 < \beta \text{ implies} \begin{cases} R_b < \dfrac{L}{Cr}\left(3 + \sqrt{8 - \dfrac{4Cr^2}{L}}\right) \\ R_b > \dfrac{L}{Cr}\left(3 - \sqrt{8 - \dfrac{4Cr^2}{L}}\right) \end{cases}$$

$$\alpha^2 > \beta \text{ implies} \begin{cases} R_b > \dfrac{L}{Cr}\left(3 + \sqrt{8 - \dfrac{4Cr^2}{L}}\right) \\ R_b < \dfrac{L}{Cr}\left(3 - \sqrt{8 - \dfrac{4Cr^2}{L}}\right) \end{cases}$$

The choice of the inequalities and the sign of the radical depends upon the values of α and β.

These relationships are presented graphically in Fig. 2. R_b/r and L/Cr^2 are dimensionless ratios of the circuit parameters introduced, in terms of the device parameters.

From the results of the theoretical analysis it is possible to select the proper circuit parameters for any desired mode of operation. Although seemingly small attention was paid to the switch mode of operation in the foregoing analysis, this was only because the assumption of a small-signal model does not fit the switch mode of operation. Certainly the properties of the bonded NR diode are such that switch operation must be carefully examined. The bonded NR diode as presently fabricated exhibits switch speeds of 3 to 10 nsec or less. These speeds compare well with those achieved with Esaki diodes. Although the switch speeds obtained with present bonded NR diodes are less than those achieved with Esaki diodes, the power-handling capability of the bonded NR diode is significantly greater. A typical switch in operation produced a 32×10^{-3} watt output pulse across a 500-ohm load resistor from a 3×10^{-6} watt input pulse. In a sense, the device may be said to exhibit logic gain in that several more diodes could be switched from the output pulse of one such diode. One drawback to the operation of the device as a switch is the high holding current in the strongly conducting state, typically 20 ma. This compares rather unfavorably with the 0.1 ma to 5 ma for the Esaki diode switch.

The shift in the dynamic or small-signal resistance of the diode in passing from the low-current to the high-current condition is quite dramatic, frequently from about 10 kilohms to 3 ohm. The shift in the static or d-c value of resistance is not so pronounced, varying from about 10,000 ohms in the low-current state to approximately 500-1,000 ohms in the high-current state. Typical diodes have been switched repeatedly using pulses having durations as short as 3 nsec, and by sinewaves at rates up to 20 Mc. The upper switching frequency limit of the devices has not yet been established.

There are two attractive features of the bonded NR diode resulting from its being a current-controlled device. One is that the power in two or more signals referred to the same ground may be added in the device. The second is that a capacitor is a natural partner to the bonded NR diode, providing both an easy means of charge storage and a ready current source.

One of the first applications of this device to be tried was a simple pulse generator, consisting of a capacitor connected in shunt across the diode and a d-c power supply. The circuit is shown in Fig. 3A, and the load line for proper operation of the device in Fig. 3B. The operation of the device as a pulse generator is achieved through the action of the capacitor. When the switch is initially closed all of the current flows through the capacitor. As charge is stored, the current flowing through the capacitor decreases and that flowing through the device increases. This process continues until the capacitor charges so that the voltage across the diode exceeds slightly the value of the peak voltage. The current through the diode now is the sum of the current from the d-c supply plus a varying current due to the capacitor discharging through the circuit. This current increases until it reaches the steady value determined by the load resistor. The speed at which this process takes place, once past the peak voltage, is governed by the growing exponential function which was found for the case of load resistance less than the negative resistance, and not by the RC time-constant of the capacitor and load resistor. The current component due to the capacitor decays until the diode current is such that the device again presents a negative resistance. Another growing exponential function then switches the device back to a state of low current flow and the cycle repeats.

The action of the pulse amplifier (Fig. 3C) is quite similar. The varying current supplied by the capacitor in the case of the pulse generator is now supplied by the input pulse. Input pulses of as little as 0.01 ma are sufficient to trigger typical devices. The d-c bias supply is chosen for monostable switching action along a load line that biases the device just slightly below the onset of the negative resistance region. While the pulse is on, the diode is held in the high-current region. As soon as the pulse is shut off, the diode current decays via a half-cycle oscillation to its low current state. The time required to switch between these states is a function of the device and not of the input pulse. The amplifier has a tendency to "square up" the input pulses.

Obviously, this amplifier is simply a fast-acting monostable switch. The bonded NR diode can easily be operated as either a monostable or a bistable switch or gate. One such gating circuit was operated as a bistable switch using input pulses of only one polarity (Fig. 3D). This circuit utilizes the negative-going spike due to average d-c level restoration, occurring on a pulse which passes through a capacitor, as well as the capacitive discharge through the unit, to achieve such a mode of operation. When the first pulse arrives, the unit switches to the high-current state. The pulse is shut off before the magnitude of the capacitor current flowing through the unit falls below the magnitude of the negative spike on the trailing edge of the pulse. The capacitor value is chosen so that when the next pulse having a negative spike on the trailing edge arrives, the capacitor has discharged sufficiently that the negative spike will cause the diode to switch back to the low-current state. If only one input is fed through a capacitor, only the pulses applied to this line will cause the diode to switch to the low-current state. Pulses applied to the device when in a stable state appear across the output resistor larger by a factor of three for the diode in the high-current state than for the diode in the low-current state in a typical circuit. Since the diode is current-controlled, gates of this type may be easily switched by using the sum of two pulses occurring coincidently.

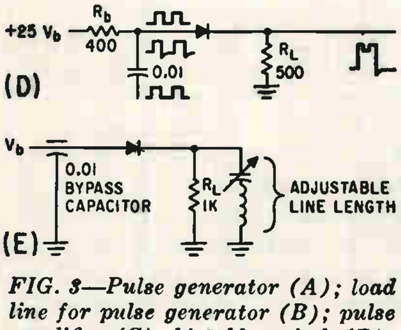

FIG. 3—Pulse generator (A); load line for pulse generator (B); pulse amplifier (C); bistable switch (D); and oscillator (E)

Oscillators using devices exhibiting fairly slow switch speeds were built. The amplitude of the oscillations was found to decrease rapidly with increasing frequency. This behavior is qualitatively consistent with the model assumed, but not at all quantitatively consistent with the predicted frequency based upon the measured values of the device parameters. The theoretical prediction is based upon the assumption that the high-frequency cutoff is determined only by the shunting effect of the junction capacitance on the negative resistance and the series resistance. While this is the case with the Esaki and varactor diodes, it is evidently not so here. For a typical unit the best measured values of the device parameters were $R = 200$ ohms, $-r = 1000$ ohms, $C = 0.4$ pf, and switch time $= 24$ nsec. These parameters indicate a cutoff frequency of approximately 1 Gc from the condition that $R_s - r/1 + (r\omega C)^2 = 0$.

In actual measurement the cutoff frequency of the device was about 36 Mc. This low cutoff frequency cannot be explained on the basis of present physical models for the device. The circuit used for the oscillator studies is shown in Fig. 3E. The highest frequency of oscillation achieved at Raytheon has been about 200 Mc. The power developed at this frequency was only about 0.8 mw. Since a rough correlation between switch speed, τ, and maximum frequency of oscillation f_c has been found to be $\tau \approx 1/f_c$, switch speeds of slightly better than 3 nsec indicate that present devices should be capable of operation up to about 300 Mc with correct circuits. Such an oscillator having several milliwatts of output power at a frequency of 300 Mc has been reported.[1] Oscillators at frequencies of a few Mc, well below f_c, have yielded powers as high as 100 mw.

A recently published paper indicates that this type of device should be capable of extension to operation in the gigacycle region.[5]

REFERENCES

(1) A. H. Reeves and R. B. W. Cooke, *Elec Comm*, 32, 2, p 112, 1955.

(2) J. B. Gunn, *Proc Phys Soc*, B69, p 781, 1956.

(3) A. F. Gibson and J. R. Morgan, *Solid State Elec*, 1, 1, p 59, 1960.

(4) R. W. Lade, *Proc NAECON XVI*, Oct. 1960.

(5) J. E. Rosenthal, *Bull Am Phys Soc*, 4, 422, 1959.

Obtaining Nondestructive Readout With Ferroelectric Memories

Electrostatically operated memory stores bits of information in terms of bistable remanent polarization. Nuclear resistant memory element is an electromechanical filter of low output impedance and high output voltage. It is adaptable to random-access memories and can store data for long periods

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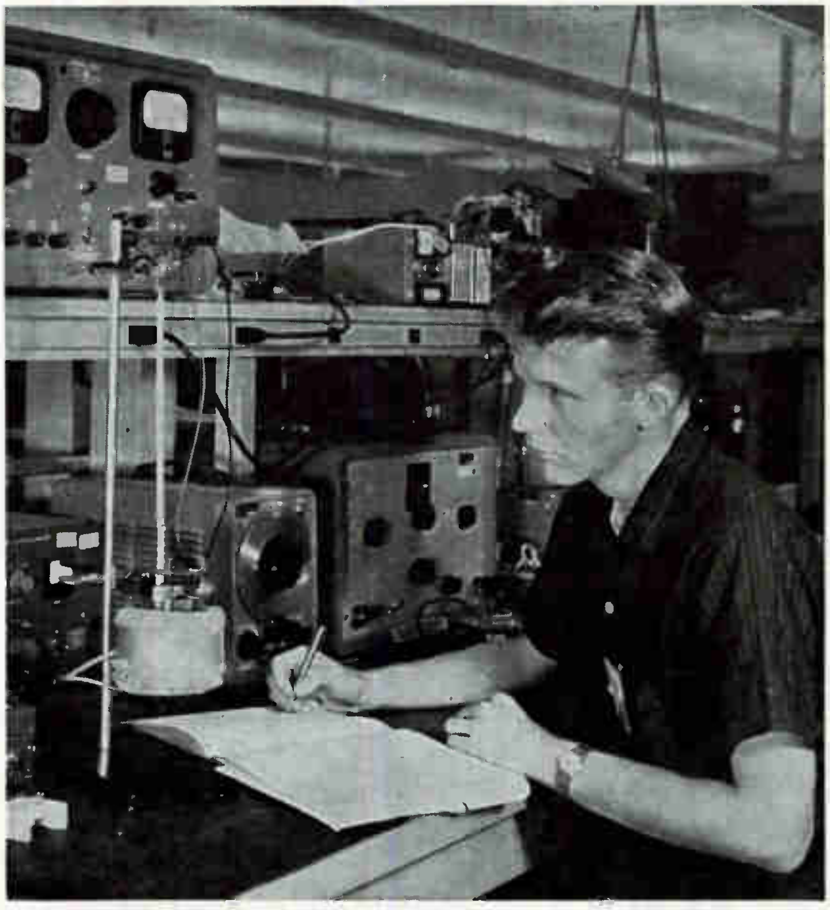
HERETOFORE, IN RESEARCH where ceramic materials such as barium titanate have been used as memory elements, the element was used primarily as a ferroelectric capacitor. The square hysteresis loop of barium titanate was considered promising for such memory applications. However, the capacitor mode of operation, in general, produced a destructive readout and this and other constraints have negated this element's use for a computer memory.[1] Furthermore, the single-crystal materials employed were difficult to handle and fabricate and, in use, did not display a high degree of reliability.

Storing information is pivotal to the whole concept of the digital computer, and development of this art has resulted in numerous storage devices and associated write-in and readout techniques.[2] Described here is a recently developed ferroelectric computer memory of much promise.

Ferroelectric memories reported in the literature have usually employed single crystal elements and, in all cases, have utilized the ferroelectric as a storage capacitor, wherein the state of the induced charge indicated the storage of a ZERO or ONE digit. These techniques have been reported on since 1952 or earlier and have not, to date, resulted in a commercially successful memory element.[3] Apart from the difficulties of practical fabrication with single-crystal $BaTiO_3$, there are inherent reasons for this. Ferroelectrics, when used for capacitor storage of a digit, produce an output signal only upon interrogation, and the subsequent readout is destructive of the stored information. This, then, requires special circuits for the rewriting of the destroyed digit. In addition, the ferroelectric capacitor is a two-terminal device that makes matrix selection without crosstalk difficult. It also precludes practical noise cancellation circuit arrangements.

A completely new approach,



Silicone oil bath brings element above Curie point, followed by slow cooling while polarization voltage is applied which negates these difficulties in connection with the use of ferroelectric elements for computer logic and memory applications, has been developed for a fixed wing highway in the sky computer program. This monomorphic polycrystalline memory cell has been designed as a four-terminal device, although it may also be used as a three-terminal device depending upon the matrix select scheme. Six-terminal memory cells are utilized where it is desirable to perform logic in the memory.

Barium titanate devices offer important design advantages for hybrid computers, and are well adapted where a large capacity, nondestructive, random-access bit or word memory, might be required. The ceramic memory device requires less supporting circuits than the conventional core matrix and is less expensive from the standpoint of materials and fabrication. Moreover, its output is volts rather than millivolts, as with core and thin magnetic film memory devices. Thus, it has the capability of directly driving a multitude of diode or transistor gates. In addition, it is insensitive to magnetic field interference, is nuclear resistant, and the associated circuits are less sensitive to noise pickup.

The barium titanate memory element consists of a polycrystalline material on which electrodes have been deposited in such a manner as to allow its functional use as a memory device. Its mode of operation is similar to an electromechanical filter that is operated near or at its resonant frequency.

Barium titanate exhibits three properties pertinent to the operation of the memory. The first of these is the electrostrictive effect. When a piece of ferroelectric material is polarized and an electric field placed across it, the material is mechanically deformed by the electrical field. Conversely, if a mechanical stress is applied to the piece of polarized material, an electrical output is observed. This second property is the piezoelectric effect. The third effect exhibited by barium titanate is the retention of polarization when the external excitation is removed. This polarization may be reversed by a reverse applied field.

The theory applied to the memory element follows. Both the electrostrictive and the piezoelectric characteristics of the material are utilized. The memory cell is made in two parts. The first of these is a permanently polarized motor element, across which a pulse or sine wave of voltage is developed by a clock signal. Thus, with an applied sine voltage, the material expands and contracts at the clock frequency. The second part is the memory element itself, which is polarized (write) in one direction or the other by a large electrical field, and which is read from the remnant piezoelectric output. For the motor element to drive the memory element, the two must be mechanically coupled.

The first configuration used in constructing a memory cell was a sandwich of two pieces of barium titanate, as shown in Fig. 1A. The pieces were silvered on both sides and bonded together with a silver-saturated Hysol resin. Leads were then attached with the same resin or with a low temperature alloy solder. This unit is referred to as a bimorph.

The bimorph provided an experimental verification of the theory of memory but had two drawbacks. The first was the difficulty in manufacturing the units. Secondly was that the maximum readout voltages were of the order of 5 to 75 mv.

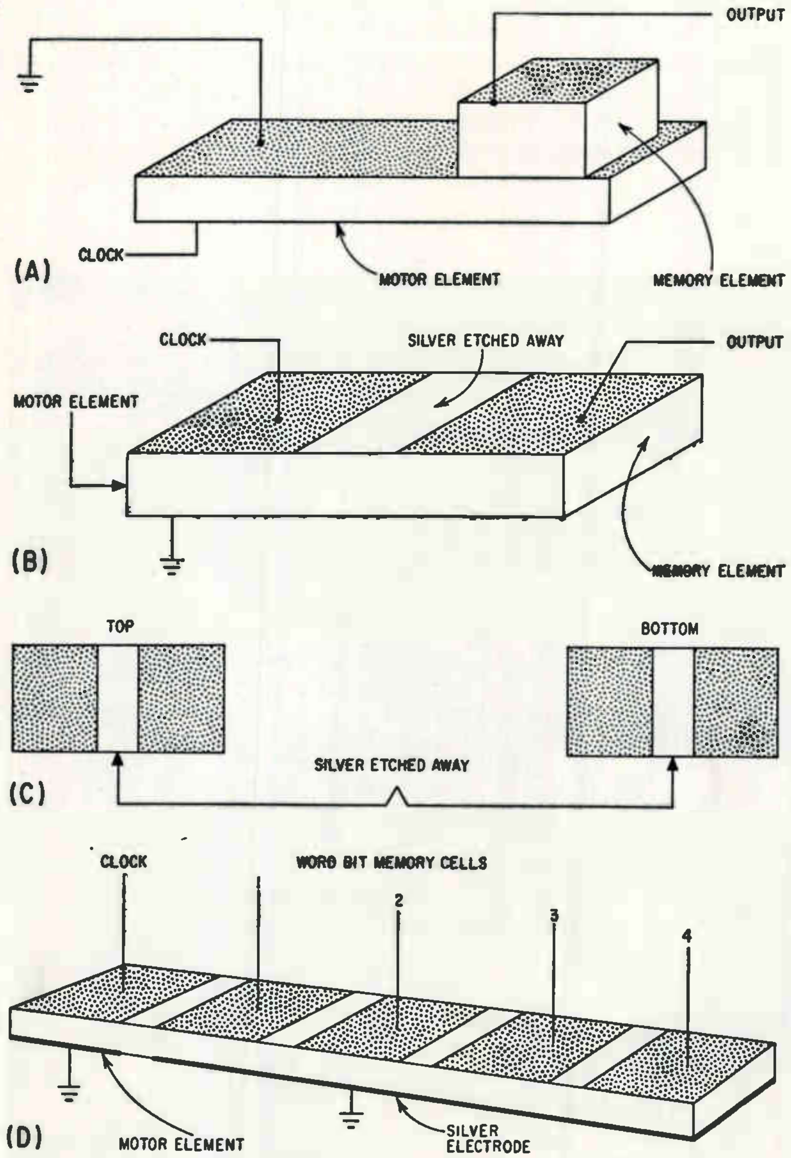


FIG. 1—Construction details of bimorph memory cell (A) and preliminary (B), modified (C), word (D) memory cells of the monomorphic type

To obtain higher readout voltages and provide a memory unit which was more easily constructed, the configuration in Fig. 1B was attempted. Output from this construction was an order of magnitude higher, or from 0.5 to 5 volts. Mechanical coupling between the motor and memory elements is considerably better in this monomorph, or single-bar unit, and, hence, the higher output voltage. The improved resonance characteristics of this unit permit a wider range of clock frequencies. Optimum materials can not be selected only on the basis of their suitability for the motor (electrostrictive) and memory (piezoelectric) portions of the cell. A compromise material must be employed which exhibits useful piezo and electrostrictive characteristics.[4]

The motor unit of the memory cell is polarized after construction by heating it above the barium titanate Curie point while approximately 50-volts d-c is applied, followed by a slow cooling.

To reduce the design complexity of a random-access memory by providing isolation between the memory and motor elements, the monomorph construction was modified slightly to the configuration shown in Fig. 1C, using the identical materials and techniques as in the original monomorph type. This newer type also operates satisfactorily.

The word-length ceramic memory cell, shown in Fig. 1D, is similar in construction and theory to the bit memory, but differs in that additional bit pickoffs are used down the strip from the motor. The mechanical propagation of the motor pulse down the strip excites each memory cell in turn, causing it to produce an output pulse whose polarity is a function of its previous history. Thus, a serial word readout may be had for a single clock pulse.

The memory cell motor element is driven by a sinusoidal clock generator. A short pulse of 35 to 150 volts d-c is applied to the memory element for write-in. Polarity of the write-in voltage determines the phase of the readout signal, referenced to the clock, and the phase of the readout signal defines the storage of a digital ZERO or a digital ONE.

Assembling ceramic memory cells. Inset shows device details

A 16-bit matrix memory has been constructed to demonstrate ceramic memory feasibility. No attempt was made to miniaturize the memory cells or the 16-bit matrix but, with the feasibility of this type of memory now established, it is expected that miniaturization will be one of the major tasks for the near future.

In its original form, an X-Y select scheme (shown in Fig. 2A) was employed, which allows selection, for example, of any one bit of a 10,000-bit matrix with 200 gates. If modified to an XYZ select scheme, only about 60 gates are needed. Unfortunately, both the X-Y and XYZ select schemes produce a second-order effect, shown by the dotted line in Fig. 3A, which limits the maximum signal-to-noise ratio obtainable, both for the ceramic memory and, in certain instances, core matrices. Certain nonselected memory cells parallel the selected cell, as shown in Fig. 3B. Depending upon the previous history of the paralleled series string of cells, the output signal may be seriously affected. Moreover, the effect of write-in voltage on the selected bit is sufficient to affect the ZERO or ONE previously written into the second-order memory cells. For these reasons, the X-Y select scheme has been replaced with a linear-select mode until these problems have been solved.

A clock frequency of 410 Kc is employed and write-in is performed at 150-volts d-c. A matrix readout gate is incorporated such that a stored ZERO produces zero output voltage and a stored ONE produces an output of approximately 5 volts peak in synchronization with the clock frequency. Two sets of switches simulate logic gating and select the memory bit into which, or from which, information is to pass.

Clock power requirements are reduced to a minimum by shunt-resonating the lumped memory cell capacitance, as shown in Fig. 2B. This technique reduces clock power

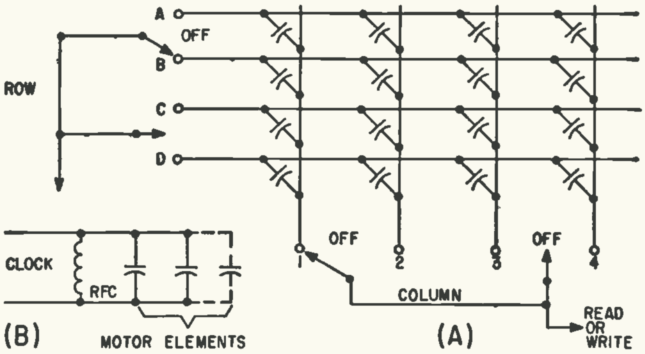


FIG. 2—In X-Y select scheme (A) clock power is reduced by shunt resonating cell capacitance (B)

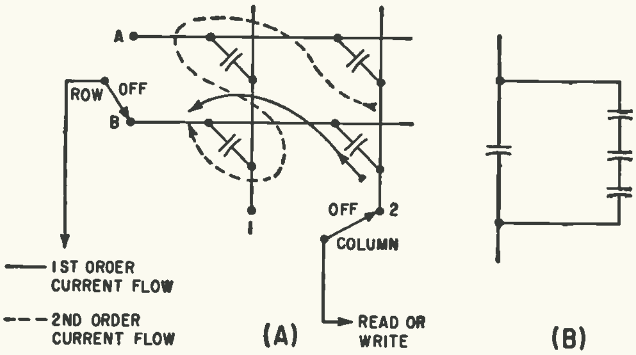


FIG. 3—Second-order effect (A) and paralleling (B) must be solved before X-Y select is usable

requirements by several orders of magnitude, as the cells no longer present a short-circuit path for the high-frequency clock.

Although a clock frequency of 410 Kc was used, this is not an upper limit. Individual memory cells have been operated at frequencies in excess of one megacycle, but air abrasion trimming of the individual cells to a selected resonance range is necessary for high frequency operation.

Literature research had indicated that the polycrystalline barium titanate memory cell material would not deteriorate significantly in performance during or after nuclear exposure to a total integrated dosage of 10^{15} n per sq cm ($E_n > 2.9$ Mev) neutrons.[5] However, it was deemed advisable to ascertain its characteristics as well as its electroding and assembly materials after irradiation. Several memory cells were subjected to irradiation but were not dynamically operated during irradiation.

Postirradiation tests indicated that the test memory cells operated satisfactorily without significant degradation of performance. The ceramic memory cells were exposed to an environment of 55 C and an integrated dosage of $\approx 1.5 \times 10^{18}$ n per sq cm at energies greater than 2.9 Mev accompanied by 8×10^{10} ergs per gm (C) of gamma. The postirradiation characteristics of a ceramic memory cell are shown in Fig. 4. Clock excitation was approximately 5 volts rms at 400 Kc. Write-in of a ZERO or ONE was at 300-volts d-c (less voltage could have been used). Readout voltage was 0.75 v peak-to-peak for the ZERO digit and 2.2 v peak-to-peak for the ONE digit. Readout nonsymmetry, though not unusual, is generally not this severe.

The monomorphic memory cell has been constructed with equal size motor and memory elements (Fig. 5). This cell (Mod I) has sharply defined characteristics relative to a usable range of clock-frequency variation. It will tolerate a ±2 to 6-Kc shift in clock frequency based on definition of the cell's output by phase reference to the clock drive. Conversely, a change in environmental temperature, which modifies the cell's resonant characteristics, limits the satisfactory range of environmental temperature to about ±5 to 10 F. If phase reference is ignored, this cell is usable over a wider frequency range ($\approx$ 80 Kc.). Variation in clock frequency affects the phase relation of the output signal relative to a sinusoidal clock. At cell resonance, the memory output is shifted 90 degrees with respect to the clock drive and these cells are normally operated 5 to 10 Kc above resonance, at which point the clock signal and memory output are in phase. Where a pulse clock is used, such as is proposed with the word storage cell, the frequency constraint does not exist because polarity gating, not phase gating, is employed.

The output signal from a Mod I memory cell, where phase-gating is employed to define the storage of a ZERO or ONE, is shown in Figure 5D and 5E. Vertical axis scope sensitivity is 2 v per div for the upper

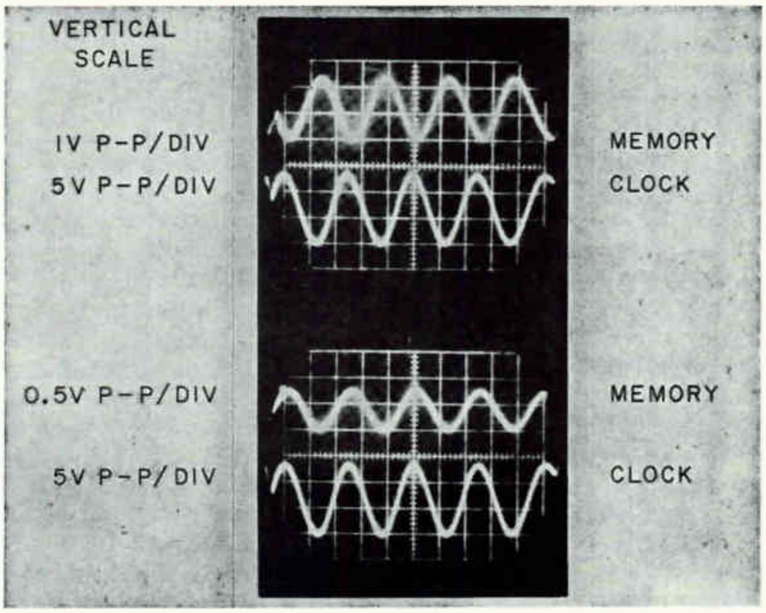


FIG. 4—Postirradiation test of readout for ONE (top) and ZERO (bottom). Horizontal scale is 1 μsec per div

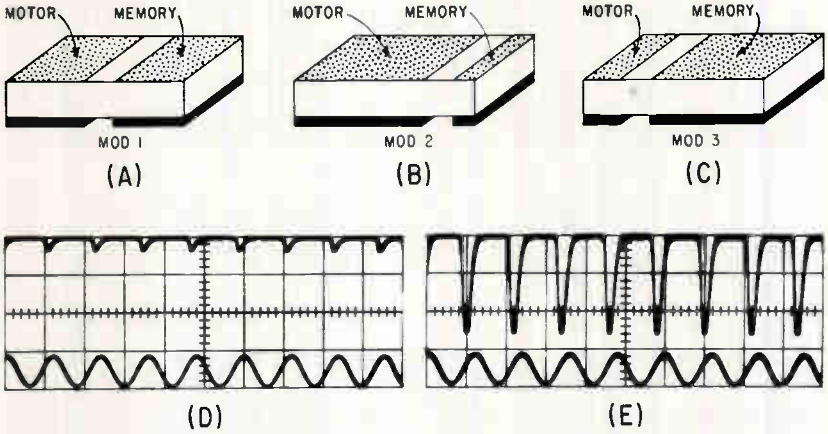


FIG. 5—Typical cell configurations are shown in (A), (B) and (C). Output for Mod I cell for ZERO (D) and ONE (E)

traces and 10 v per div for the lower traces (clock). The oscilloscope presentation reveals a ZERO output signal of 0.8 v and a ONE output of 5.2 v. The ZERO output is an artifact in the memory matrix, and is not due to the cell. Cell output impedance is approximately 1,000 ohms and clock frequency is about 400 Kc. The ONE output signal shows that the negative spikes are not in perfect phase synchronization with the clock motor drive signal.

To improve temperature environment characteristics and lower clock frequency dependence, several new geometries of cell configurations were constructed and tested. Two are shown in Fig. 5B and 5C. The Mod II and III cells employ a ratio between the motor and memory elements of about 4 to 1. Using a clock phase-referenced gate, the Mod II cell clock frequency (about 400 Kc) may be varied ±2 to 6 Kc with no impairment of memory cell readout. This offers no improvement over the Mod I memory cell, but does result in a cell with two major resonant points (400 Kc and 900 Kc for one selected cell). The Mod II cell appears worthy of further study because of indications that slight modifications in the geometry may produce operation over wider temperature environments. The Mod III cells tested to date resonate at approximately one megacycle.

Complete evaluation of the Mod II and III cells is not finished. The sample lots constructed were not sufficient in magnitude to certify that the results noted are completely representative.

Memory cells are constructed from diced slabs of polycrystalline barium titanate, fully silvered on both sides. The silver is etched away on each side to form the motor and memory elements, and the lead wires are then attached to the cell with a silver-saturated, tin-lead solder.

Placement and stiffness of the lead wires, as well as the physical size and characteristics of the cell material, determine electromechanical resonance and no two cells have exactly the same resonant frequency. This offers no problem when the operation of one cell is considered, but the operation of a multitude of cells is severely hampered by this lack of uniformity. Two alternative approaches are possible; the first is to select nearly similar resonant cells from a large production run of cells. This approach has been used to date but, unfortunately, no gaussian curve of distribution has been found, with the result that the yield of usable matrix cells has been too low to be practical. Moreover, this technique of cell selection is not feasible where a preselected clock frequency is desired.

A better approach is to use an air abrasion system to tailor each memory cell to an exact and preselected resonant frequency. Procedures and techniques for this are similar to transmitting-crystal frequency adjustment. Instead of a grinding action, where thickness is modified, the length or width of the memory cell is reduced until it is operating at the preselected resonant frequency. The equipment supplies sand blast action that is suitable for etching or cutting brittle materials such as barium titanate. Although ultrasonic machining could be employed, it is not suitable because it does not permit trimming to resonance while the cell is operating. In practice, most of the Mod I cells resonate between approximately 350 to 420 Kc and all of these would be tailored, for example, to 450 Kc. Since the leads are attached before trimming, the cells are in a completed form, thus eliminating lead attachment geometry and stiffness as contributing factors.

Additional research is required to produce the optimum ferroelectric memory cell. There are two variables dealing with the material itself: the types and concentrations of chemical impurities and the firing cycle.

A second area for investigation concerns the geometry of the memory element. The geometric variables are shape, size and vibration mode. For example, disk configurations will be tried and compared with the bars now being used.

In addition, research is needed to determine the feasibility of taking the raw material and doping half of it to construct a motor element that will exhibit improved electrostrictive properties, and doping the other half to construct a memory element that will exhibit improved piezoelectric properties and ease of switching.

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REFERENCES

(1) J. A. Rajchman, Computer Memories, A Survey of the State-of-the-Art, *Proc IRE*, **49**, No. 1, Jan. 1961.

(2) C. F. Pulvari, Ferroelectrics and Their Memory Applications, *IRE Trans on Component Parts*, **CP-3**, p 3, Mar. 1956.

(3) J. R. Anderson, Ferroelectric Storage Elements for Digital Computers and Switching Systems, *Electrical Eng*, Oct. 1952.

(4) J. W. Crownover, Electrostrictive Ceramic Materials, U. S. Patent No. 2,836,501, May 27, 1958.

(5) I. Lefkowitz, *Phys Chem Solids*, *10*, 169, 1959.

Feedback Amplification Improves

Two major shortcomings of the Hall-effect multiplier are overcome by using a feedback amplifier to drive the field coil current in phase with the input signal and by adding a d-c component to the field coil signal

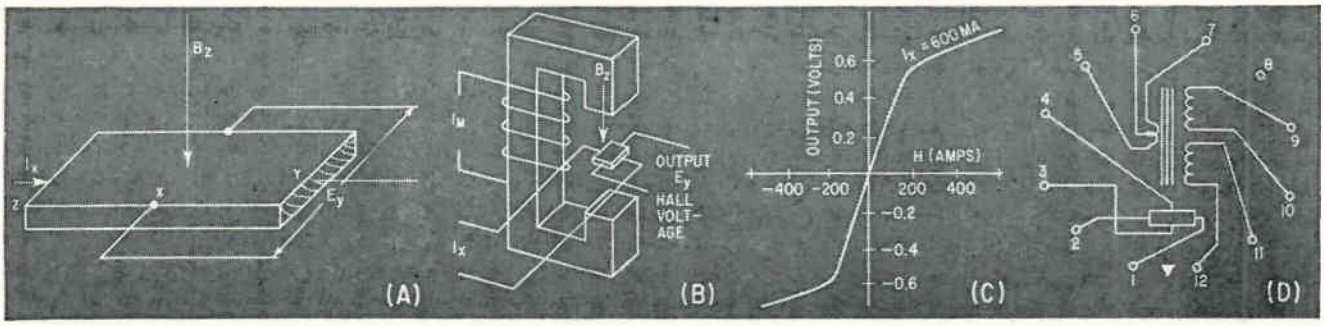

FIG. 1—Generation of Hall voltage (A); basic Hall-effect device (B); Hall voltage as a function of mmf for a fixed value of current through indium arsenide crystal (C); and the magnetic circuit of the conductor and coil device used in work discussed in text (D)

A POTENTIAL difference is developed across a current-carrying conductor when the conductor is placed in a magnetic field, as shown in Fig. 1A. This is the well-known Hall effect. The voltage E_y that appears across the terminals can be shown to be

$$E_y = \frac{1.18\,\mu\, I_x\, B_z}{\sigma z} \qquad (1)$$

for a semiconductor, where μ is electron mobility and σ is conductivity.[1] Since the Hall voltage is directly proportional to the product of I_x, current through the conductor, and B_z, applied field, the effect can be used to take the product of two signals if the signals control I_x and B_z. Figure 1B shows a configuration of a Hall-effect device.

Choice of conductor material is a primary consideration. Equation 1 shows that a material with high electron mobility and low conductivity is desired for a large Hall voltage output. Some semiconductor materials have these properties. Indium arsenide has an electron mobility about 850 times that of copper, while indium antimonide has a mobility 2,400 times that of copper. However, the ratio of the mobility to conductivity of indium antimonide is severely temperature sensitive, while that of indium arsenide stays constant over the temperature range from minus 65 to plus 75 degrees C. Thus indium arsenide is preferable.

The magnetic configuration is also important. The semiconductor material is placed in the air gap of the magnetic circuit. The air gap helps to linearize the magnetic circuit, but also requires a larger mmf to attain the desired B field. Thus, the gap is made as small as possible, equal only to the thickness of the semiconductor plate. Equation 1 shows that the thinner the semiconductor, the higher the Hall voltage. The power capability of the element is also inversely proportional to the thickness of the semiconductor, because the internal resistance is inversely proportional to the cross-sectional area. The minimum thickness is, however, limited by mechanical considerations and dictates the minimum air gap.[2]

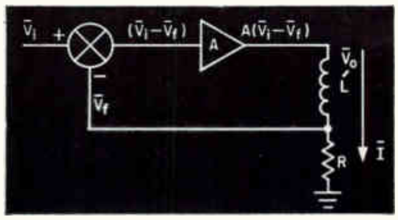

FIG. 2—Feedback amplifier circuit

The conductor and coil device used in the work covered here was the model MC-4 Halltron magnetic circuit, built by the Ohio Semiconductor Company. The conductor is a crystal of indium arsenide. The core material can be driven to linear flux densities of well over 10 kilogauss.[3] This enables a fairly high output Hall voltage to be produced. Figure 1C shows the output Hall voltage as a function of the mmf of the magnetic circuit for a fixed value of current through the semiconductor crystal.[3]

The MC-4 has a coil with two windings. Their inductance is 60 mh when connected in parallel. Coil resistance is ½ ohm; self-resonant frequency is 104 Kc. The magnetic circuit is shown in Fig. 1D. The semiconductor crystal has a resistance of about 1.2 ohms at the current input terminals, and a resistance between the output terminals of about 0.8 ohm.[3] The auxiliary winding nulls out the voltage induced in the output leads by the changing field.

Assuming a linear magnetic cir-

Hall-Effect Multipliers

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cuit such that B_z, the field, is given by

$$B_z = KI_m \tag{2}$$

where I_m is the current through the coil, then

$$E_y = K' I_x I_m \tag{3}$$

Thus the Hall-effect circuit multiplies currents, but in most applications it is desirable to multiply voltages. Since the semiconductor crystal is practically a pure resistance, it is not difficult to drive through it a current that is in phase with the signal voltage. Hence the output Hall voltage will be directly proportional to the voltage applied to the crystal. Generally a series resistance will be required to make the changes in resistance of the semiconductor with temperature and magnetic field have a negligible effect on the total load. Since currents up to 500 milliamperes through the crystal are desired, some power amplification will be needed in the driving circuits.

The coil generating the magnetic field presents a more difficult problem. If a voltage signal is applied to the terminals of the coil, the current through the coil will lag the signal voltage by almost 90 degrees, because the circuit is inductive at high frequencies. The output Hall voltage will then be the product of signals which appear at the input at different times, and in most applications, with time-varying signals, this would be undesirable.

One method of minimizing the phase shift between the signal voltage applied to the field coil circuit and the coil current is to place a large resistor in series with the coil. However, this method has limitations. If there is a maximum signal voltage that can be produced, and a maximum current desired through the coil, the maximum resistance that can be placed in series with the inductor can be determined. If a transistor amplifier is used as an input, the maximum voltage achievable at the output is limited by transistor breakdown voltage, which is about 100 volts. For the MC-4 multiplier, a coil current of up to one-half ampere is desired. The maximum resistance which can be placed in series is then about 200 ohms.

For the phase shift to be small, $\omega L/R$ should be less than 1/10.

$$\omega = \frac{R}{10\,L} \tag{4}$$

Thus where ω is the maximum value of angular frequency. In the parallel connection $L = 60$ mh, and

$$f_m = \frac{\omega}{2\pi} = \frac{200/2\pi}{10 \cdot 60 \cdot 10^{-3}} = 53 \text{ cps} \tag{5}$$

This is the maximum frequency at which one-half ampere can be driven through the coil with a phase shift of less than about five degrees, if amplifiers are used whose peak output voltage is about 100 volts.

To drive the current through the coil in phase with the signal voltage, while keeping the series resistance as small as possible, a feedback amplifier circuit such as in Fig. 2 can be used.

If no load current passes through the feedback connection, then

$$I = \frac{V_o}{R + j\omega L} \tag{6}$$

and

$$V_f = IR = \frac{V_o R}{R + j\omega L} \tag{7}$$

Assuming an amplifier gain, A,

$$V_o = A\,(V_i - V_f) \tag{8}$$

Substituting for V_f in Eq. 8 from Eq. 7 and for V_o from Eq. 6

$$I = \frac{V_i}{R\,(1 + 1/A) + j\,\dfrac{\omega L}{A}} \tag{9}$$

$$I = \frac{V_i}{R + j\omega L/A} \tag{10}$$

From Eq. 10, the feedback is shown to reduce the magnitude of the reactance by the magnitude of the open-loop gain of the amplifier. If the same criteria is used for the phase shift, X_L/R less than 1/10, then

$$\frac{2\omega f L/A}{R} = \frac{1}{10} \tag{11}$$

or

$$f_m = \frac{RA}{2\pi\,L \cdot 10} \tag{12}$$

Equation 12 gives the frequency limit at which the signal voltage and coil current will be approximately in phase. At this frequency the phase shift is 5.8 degrees. For $A = 1{,}000$, $R = 25$ ohms, and $L =$

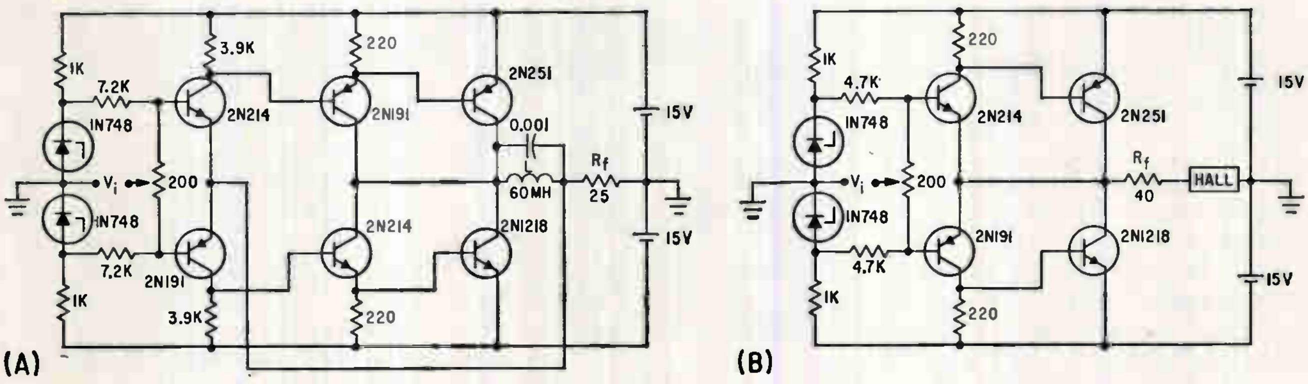


FIG. 3—Feedback amplifier used to drive field coil (A), and amplifier used to drive the current through the semiconductor plate (B)

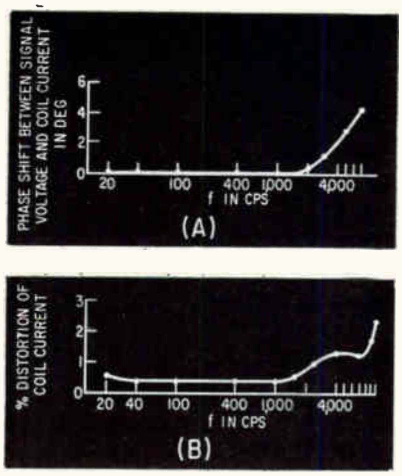


FIG. 4—Plot of phase shift between coil current and signal voltage of the amplifier connected in the feedback configuration (A), and percent total harmonic distortion in the coil current (B)

60 millihenries, Frequency is

$$f_m = \frac{0.1 \cdot 25 \cdot 1{,}000}{2\pi \cdot 60 \cdot 10^{-3}} = 6.65 \text{ Kc} \quad (13)$$

If the limit of the peak voltage of the driving amplifier output is again taken to be 100 volts, then the highest frequency at which 500-ma peak current can be driven through the coil is simply that frequency at which $2\pi f L \bar{I} = 100$, or

$$f_m = \frac{100}{2\pi \cdot 60 \cdot 10^{-3} \cdot 0.5} = 530 \text{ cps} \quad (14)$$

If higher frequencies are to be multiplied, the coil current must be kept proportionally smaller and lower Hall voltages will occur. In most waveforms, however, the higher frequency components are smaller and they can be accommodated. This is especially true where integrators are used in analog computer equipment, since the integration acts to smooth the waveform.

In most multiplier applications, d-c as well as a-c signals must be accommodated. Thus, the driving amplifiers should be d-c coupled. No current should pass through the load, either the coil or the semiconductor crystal, when there is no input signal. To accomplish this, a balanced circuit with matched pairs of *pnp* and *npn* transistors was used.

The schematic diagram of the feedback amplifier used to drive the field coil is shown in Fig. 3A. The transistors of each of the stages are approximately matched for common emitter current gain, h_{fe}. Some of these transistors have breakdown voltages near 30 volts. Thus, supply voltage was limited to 30 volts.

The 0.001-μf capacitance in parallel with the coil prevents high-frequency ringing. Within the range of frequencies where the phase shift can be kept small (up to about 7 Kc) the reactance of this capacitance is so large that it has a negligible effect on the phase shift.

Figure 4A, a plot of the phase shift between coil current and signal voltage of the amplifier connected in the feedback configuration, shows that the feedback circuit keeps the coil current in phase with the signal voltage over the frequency range from 0 cps to about 7 Kc as predicted by Eq. 13. Figure 4B shows the percent total harmonic distortion in the coil current. This distortion is less than 1.5 percent over the useful frequency range.

The circuit diagram of the amplifier that drives the current through the semiconductor plate is shown in Fig. 3B. With this amplifier, the current remains in phase with the signal over a frequency range from 0 cps to above 20 Kc. Distortion is less than one percent over the entire range.

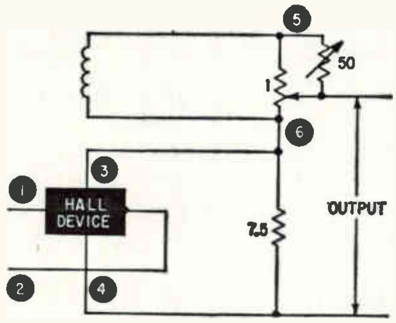


FIG. 5—Method for eliminating the voltage induced in the crystal output leads

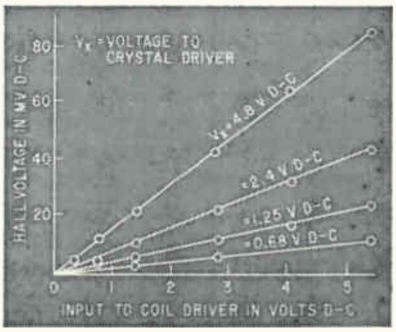


FIG. 6—Hall output voltage plotted against d-c voltages applied to driving amplifiers

There are several factors that obscure the output voltage from the multiplier. One of these is an induced voltage in the output leads of the crystal (these leads form a closed loop in the field set up by the current through the field coil). Another is the common-mode signal impressed upon the Hall voltage with respect to one end of the crystal. This common-mode signal occurs because one end of the crystal is at ground potential, with the output leads connected to equipotential points on opposite sides of the crystal. The potential of the output leads above ground is the common-mode signal, and is therefore proportional to the signal voltage to the crystal driver.

In addition, an output voltage may exist at zero field. This voltage (null voltage) is due to the fabrication difficulties encountered in connecting the Hall output leads to the crystal. The magnitude is proportional to the crystal current, hence to the signal applied to the crystal driver, and depends on how closely the output leads are connected to equipotential points on opposite sides of the crystal.[3] In the MC-4, the magnitude of this voltage at 400-ma peak current through the crystal is about 0.7 mv peak.

To eliminate the voltage induced in the output leads of the crystal, a portion of the voltage induced in the auxiliary winding (shown in Fig. 1D) is connected in series with the output voltage in such a polarity as to null the induced voltage in the leads (see Fig. 5). Adjustment of this voltage reduces the amount of induced voltage in the output to about 0.14 mv peak-to-peak when a signal of 30 volts peak-to-peak at 1,000 cps occurs across the coil. This voltage stays less than 0.5 mv peak-to-peak with 30 volts peak-to-peak across the coil over the entire frequency range of the multiplier.

In most multiplier applications, it would be desirable to refer the output voltage to ground. The output has impressed upon it a common-mode signal which is, at best, of magnitude equal to the desired signal, and may be many times larger than the desired signal if

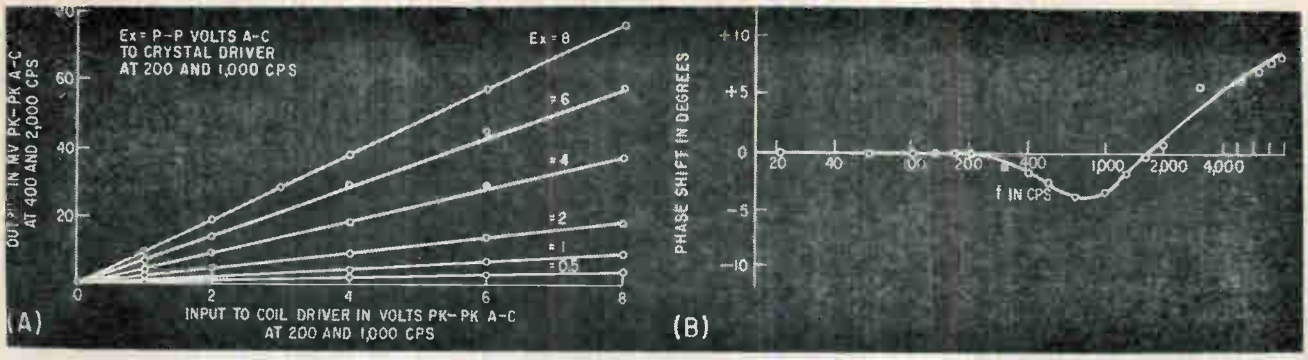


FIG. 7—Typical data for a-c vs a-c multiplication (A). Phase shift between signal applied to coil driver and output Hall voltage with 100 ma d-c in the crystal (B)

the signal applied to the coil driver is small. Thus, to refer the output signal to ground, a difference amplifier with a high common-mode rejection is needed. A difference amplifier with a common-mode rejection ratio of 10,000 to 1 was connected across the output terminals in Fig. 5 and was used to take data.

Common-mode signals may be further reduced, and the null voltage may be cancelled, by applying a small d-c input to the coil in addition to the signal being multiplied. The input to the coil driver then becomes $E_{d\text{-}c} + E_1 \cos \omega_1 t$; and if the signal applied to the crystal driver is $E_2 \cos \omega_2 t$, the output of the difference amplifier will be

$$E_{out} = K_1 (E_{d\text{-}c} + E_1 \cos \omega_1 t)\, E_2 \cos \omega_2 t + K_2 E_2 \cos \omega_2 t \quad (15)$$

where $K_2 E_2 \cos \omega_2 t$ is the common-mode signal in the difference amplifier output plus the null voltage. Expanding Eq. 15,

$$E_{out} = K_1 (E_{d\text{-}c} E_2 \cos \omega_2 t) + K_1 E_1 E_2 \cos \omega_1 t \cos \omega_2 t + K_2 E_2 \cos \omega_2 t \quad (16)$$

Desired output of the multiplier is the product term only, $K_1 E_1 E_2 \cos \omega_1 t \cos \omega_2 t$, since this is the product of the two inputs. If $-K_1 E_{dc} = K_2$ only the product term will appear in the output. Thus, the lack of common-mode rejection in the difference amplifier, and the presence of a null voltage, can be compensated for by a small d-c voltage added to the input signal to the field coil driver, and high common-mode rejection is then not necessary.

All data on the output Hall voltage was taken with sufficient d-c added to the field coil current to achieve good common-mode rejection and to compensate for the null voltage. With the same frequency signal applied to both the field coil driver and the crystal driver, the output was proportional to the products of these inputs. That is, the output contained an a-c signal of twice the frequency of the input signals, and a d-c component of equal magnitude to the peak value of the a-c output. This is exactly the output that should be expected from a multiplier, since

$$(E_1 \cos \omega_1 t)(E_2 \cos \omega_1 t) = E_1 E_2 \cos^2 \omega_1 t = \frac{E_1 E_2}{2} + \frac{E_1 E_2}{2} \cos 2\,\omega_1 t \quad (17)$$

A wave analysis of the output revealed a term of $\cos \omega_1 t$ at 40 to 50 db down from the $\cos 2\omega_1 t$ term, dependent upon the care exercised in the adjustment of the d-c current through the field coil which was used to enhance the common-mode rejection.

When different frequencies were applied to the two inputs, 4,000 cps to the crystal driver and 1,500 cps to the field coil driver, the output contained only the sum and difference frequencies, 5,500 cps and 2,500 cps, as would be expected. A frequency analysis of the output waveform showed for inputs of 0.34 volt rms at 1,500 cps to the coil driver and 2.5 volts rms at 4,000 cps to the crystal driver, the output at 1,500 cps was 0.8 mv rms or −60 db; at 2,500 cps was 1.03 v rms or +2.5 db; at 4,000 cps was 0.7 mv rms or −61 db; and at 5,500 cps was 1.03 v rms or +2.5 db.

Figure 6 shows the Hall output voltage as a function of the d-c voltages applied to the driving amplifiers. The multiplier is linear. The linearity of a-c against d-c multiplication was found to be linear within five percent over the range of frequency inputs.

Some typical data for a-c against a-c multiplication appear in Fig. 7A. An a-c signal from the same source was applied to both inputs, and the a-c output of the multiplier was measured. Because of the multiplication, the output frequency is twice that of the input. The linearity of multiplication was checked at both 200 and 1,000 cps, and the results were found to be the same at both frequencies.

Figure 7B shows the phase shift between the signal applied to the coil driver and the output Hall voltage with a current of 100 ma d-c in the crystal. The phase shift is dependent on the adjustment of the bucking voltage. Here, the bucking or quadrature voltage was adjusted for a null in the output voltage at 1,000 cps with the crystal open-circuited. The phase shift under these conditions is less than five degrees at frequencies up to 4,000 cps. The distortion of the output voltage under these conditions was 2 percent or less with sufficient magnitude of signal to avoid measuring noise.

The phase shift between the applied signal to the crystal driver and the output Hall voltage with 100 ma d-c in the coil was also studied. This phase shift was less than four degrees over the frequency range of the test oscillator, from 20 cps to 20 Kc. The distortion in the output signal under these conditions was less than 1 percent over the frequency range.

REFERENCES

(1) R. A. Greiner, "*Semiconductor Devices and Applications*," McGraw-Hill Book Co., Inc., New York, 1961, p. 80.

(2) T. Barabutes and W. J. Schmidt, Principles and Considerations in the Design of a Hall Multiplier, Conf. Paper, AIEE Air Transportation Conf., Seattle, Wash., June 1959.

(3) Technical Data and Applications Information, Application Bulletins of the Ohio Semiconductor Co., Columbus, Ohio.

Measuring Transient Light With

When using vacuum phototubes to measure transient light, precautions are relationship. This article discusses the problems involved. For many tests,

By HAROLD E. EDGERTON
RICHARD O. SHAFFNER,
M. I. T. Cambridge, Mass.

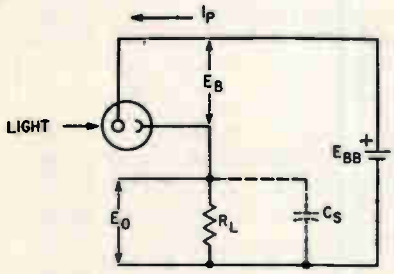


FIG. 1—Measuring circuit illustrates the problems of achieving linear light-current relationship

OF THE many different light-detecting devices, the vacuum phototube appears best for measuring transient light, since a linear current-light relationship is possible, whereas with photovoltaic and photoconductive devices there are undesirable nonlinear and thermal effects. Even with a vacuum phototube, certain circuit conditions must be maintained on the phototube to achieve a linear light-current relationship.

In the measuring circuit of Fig. 1, for example, the anode voltage, e_b, must be greater than some minimum value depending upon the light. With a given light flux, L_1, on the cathode, the current output, i_p, is a function of the anode voltage up to the saturation value, as shown in Fig. 2A. Then as the voltage is increased the current does not change appreciably, corresponding to the linear region where output current is proportional to light flux. The phototube must be used where this saturation current condition exists if the current is to be a calibrated measure of light.

Incident daylight on a surface perpendicular to the sun's rays is approximately 10,000 lumens per square foot. The curve marked L_1 in Fig. 2A is for three times daylight. With a more intense light, L_2 or L_3 (5× and 7× daylight), a higher voltage is required to reach the saturation value. Saturation current can be plotted against anode voltage by using a series of different intensities of light.

The anode voltage requirement must include the influence of the electrical load. In Fig. 1, light on the phototube causes current to flow, resulting in a resistive drop or out-put voltage, e_o, across the load resistor, R_L, thus reducing voltage across the tube. As R_L is increased for more output, e_b drops. This anode voltage should never decrease below that required for saturation current, since the current-light relationship will not be linear. In Fig. 2A, for example, for the curve marked $R = 20{,}000$ ohms, output voltage is almost the same value with L_2 and L_3. However, if resistance is decreased to 1,000 ohms, the useful linear relationship is reestablished but with a reduction of output, e_o. For the larger resistance, E_{bb} should be increased until the intersection of the load line with the L_3 curve falls on the saturation current corresponding to L_3. One can test the linearity of a phototube system by increasing the supply voltage or by increasing the light. In the first case, the output should remain constant whereas in the second, the output should be proportional to the light if the system is linear.

In measuring the rapidly changing light output of a flashlamp as a function of time, voltage across the load resistor in series with the phototube will be proportional to the light incident upon the cathode. A cro displays the signal with a time sweep across the screen.

A limitation encountered with transient light is the time constant of the light measuring circuit, including: the load resistor, R_L, in parallel with all the capacitance, C, (Fig. 1), due to the cro input leads, phototube and circuit wiring. The time constant is the R-C product in seconds.

Consider a one-megohm load resistor connected to an oscilloscope that has an input of twenty picofarads, and a circuit capacitance of thirty picofarads. The time constant is fifty microseconds. If this circuit records the light from a one-microsecond pulse of light, an erroneous result will be obtained. The circuit will act as an integrator during the light flash, followed by an R-C exponential discharge of the capacitances through the load resistor. The oscilloscope will display the time constant (50 microseconds) of the measuring circuit if the flash of light is short compared to the time constant.

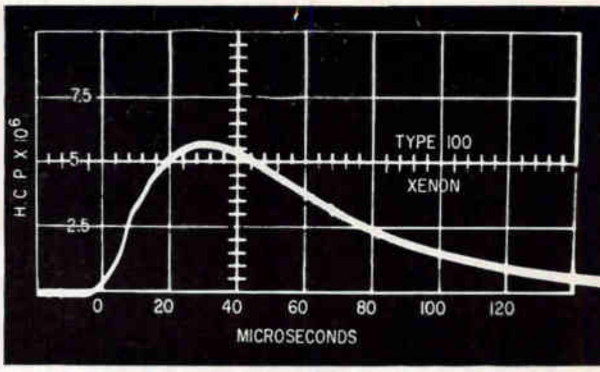
The circuit time constant must be smaller than the flashlamp light decay time if the light measurements are to be meaningful. The time constant should be about 0.1 microsecond. This calls for a load resistance of 2,000 ohms, with a correspondingly lower output voltage.

Now the photo tube must produce abnormally large currents if the output is to be increased. When this is done the knee of the curve extends further into the linear portion requiring a high value of E_{bb} to insure linearity. A phototube such as the RCA-929 can be used with 600 volts on the anode, and with peak currents of 10 to 20 milliamperes. In Fig. 2B, where this phototube is used, minimum time constant is 15 nanoseconds with $R_L = 100$ ohms. For higher voltages than 600, tubes such as the RCA-935 are preferable.

Vacuum Phototubes

required to achieve a linear current-light

light readings are made directly on a cro



For this time-intensity trace, a 100-μF capacitor charged to 1,400 v was discharged into an EG&G type 100 flashlamp. Peak output, 6 million candle power; duration, 72 microseconds

One phototube circuit used at M.I.T. for measuring fast flashing lights has 2,000 volts on the anode of a 935 tube, and a 100-ohm load resistor. The time constant is about 10 nanoseconds, which is about the limit of time measurement of many oscilloscopes.

For light measurements, phototube sensitivity is a function of the spectral character of the light to be measured. Various spectral response curves are available and are specified as S-1, S-4, S-11. (See RCA manual for surface characteristics.) The S-4 photoelectric surface is stable and sensitive but it has low sensitivity in the red portion of the spectrum. When a match to the eye visibility curve is desired, this lack of red sensitivity is serious.

A good match of the eye visibility curve can be achieved by using a Wratten 106 filter with an S-4 or S-5 surface (with a drop in sensitivity to daylight of about 7 to 1). If the phototube sensitivity curve is desired to match the photographic spectral sensitivity of films, especially blue-sensitive emulsions, then the phototube with the unfiltered S-4 surface is ideal.

Direct calibration with a known continuous light source of a phototube with high voltage on the anode and a low value of load resistance is difficult and may be inaccurate due to destructive thermal effects. However, with a flashlamp whose output is known, readings can be compared.

Xenon flashlamps are useful for calibration since their output is consistent in value, and in color distribution, if the voltage and capacity are controlled. One such flashtube is the FX-1 of EG&G (Edgerton, Germeshausen & Grier) whose characteristics have been measured over wide input conditions. For example, a flash from 100μF charged to 1,000 volts has a peak output of one million horizontal candle power in a direction at right angles to the lamp.

The light energy incident on the cathode, if the lamp and phototube are spaced greater than 6 feet apart, is $L = (\text{HCP}/D^2)\ (A_c)$ where L = incident lumens entering phototube, HCP = horizontal candle power of lamp, D = lamp to phototube distance, and A_c = effective area of phototube cathode expressed in the same units as D^2.

Suppose the sensitivity, S, of the phototube (929 of Fig. 2B) is 116 μa per lumen with xenon-colored light, then the peak output current is $i_p = (\text{HCP}/D^2)\ (A_c)\ (S) = (10^6)\ (3.52 \times 10^{-3})\ (116 \times 10^{-6})/D^2 = 0.407/D^2$ where i_p is in amperes, and D is in feet.

Peak output voltage is: $e_{o\,peak} = (R_L)\ (i_{p\,peak}) = 0.407\ R_L/D^2$ where e_o is in volts, R_L is in ohms and D is in feet.

When many tests are to be made, it is convenient to arrange D, R_L and an optical filter so that the deflection on the oscilloscope is an integral number of light units. Then the light readings can be made directly from the oscilloscope. The phototube is moved back and forth until D is the correct value to make a peak deflection of one marker unit on the cro screen. For an unknown flashlamp at the same distance, the peak light can be then read directly from the oscilloscope screen in millions of candle power.

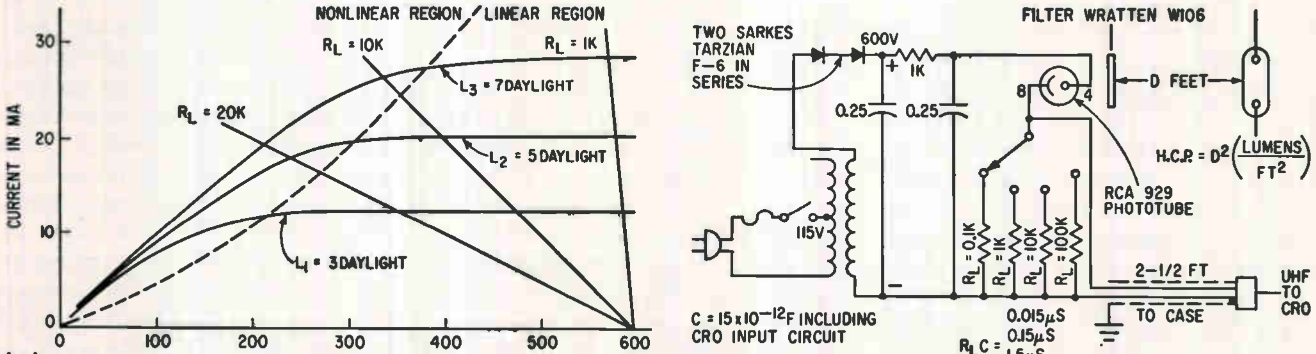
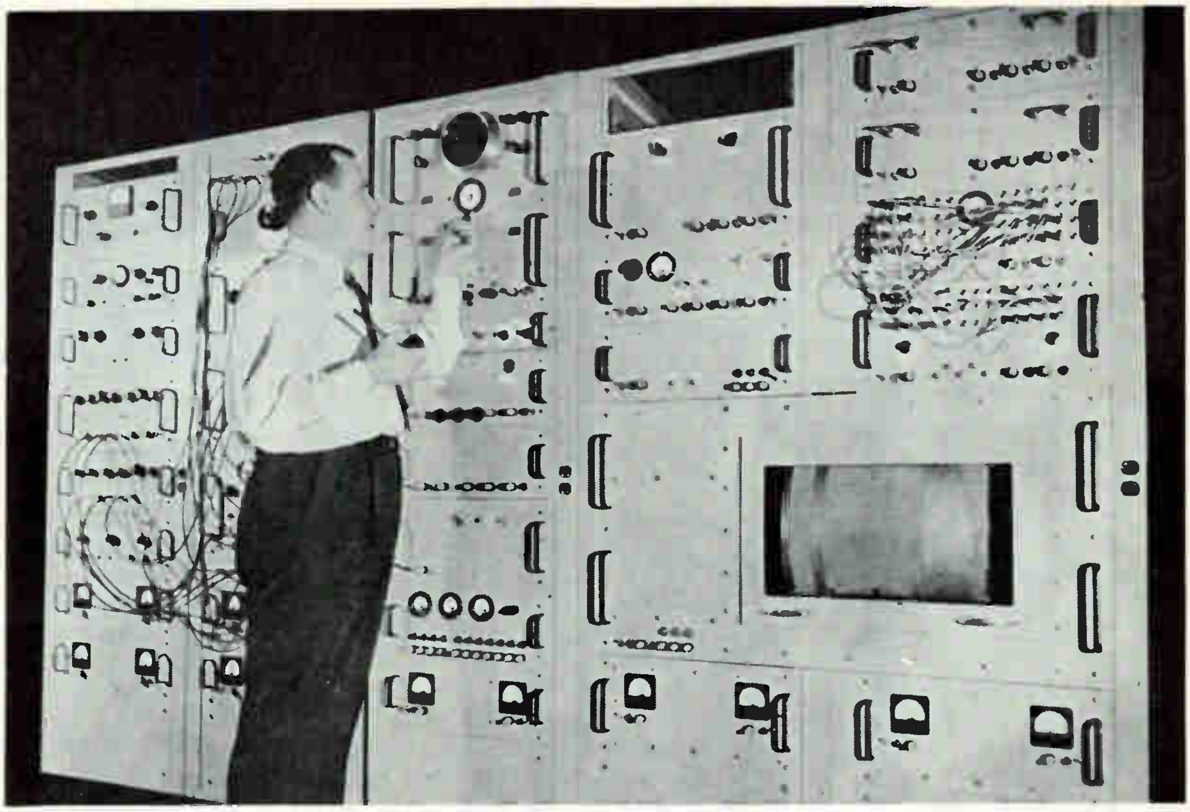


FIG. 2—Average volt-ampere characteristics of 929 phototube for different light flux densities (A). Xenon flash light has spectral energy distribution corresponding to daylight. Schematic for a-c operated light-measuring device for use with oscilloscope (B)



Target generating equipment is in the three racks at right, ecm equipment is in the two racks at left

Search-Radar Analog Simulator

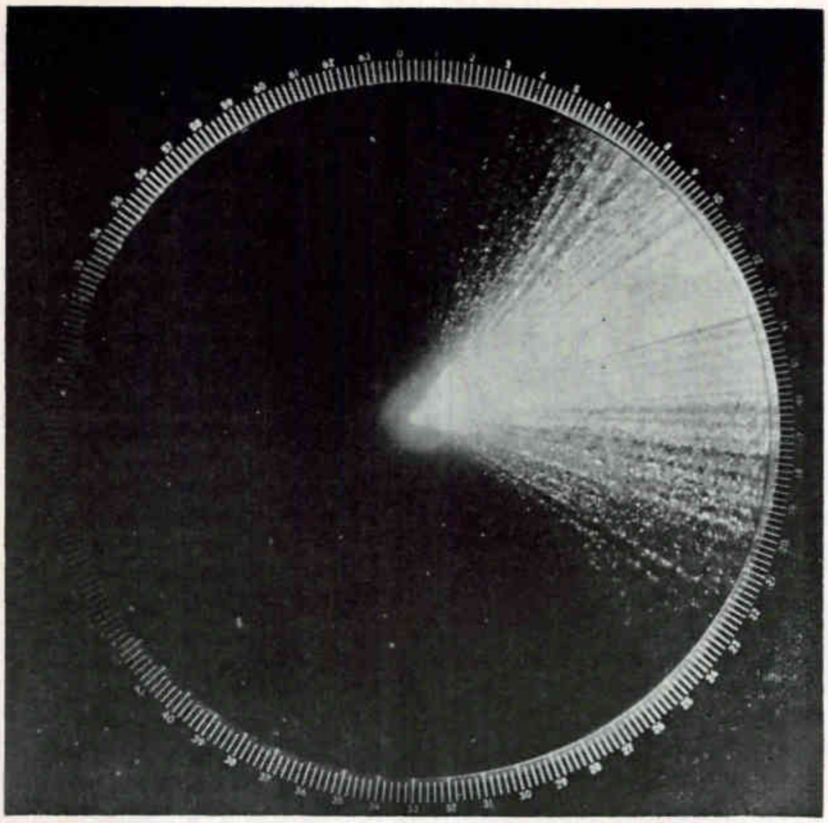
By L. G. FISCHER
G. FRENKEL
ITT Federal Laboratories, Nutley, New Jersey

THE GROWING use of evaluators, simulators and training aids has led to a large variety of such equipment. The simulator spectrum ranges from devices whose primary aim is achieving a subjective similarity to practice runs by fighters on bombers and to other real life situations. Such systems are mainly used as training aids. At the other extreme of this hypothetical spectrum are abstract mathematical models, in which the generated signals or displays bear no resemblance whatsoever to real life. Such devices are used ordinarily as design tools and solvers of theoretical problems.

Both approaches have limitations. For example, a device of the first type, superficially life-like in presentation but actually synthetic, may present to the trainee a challenge different from that encountered under field conditions. If his reactions and his operation of controls are unnatural, he will be detrained rather than trained. Limitations are also observed with mathematical models, since the results obtained are only as valid as the formulating hypotheses. Often conclusions diametrically opposed to actual results are obtained, indicating serious errors in assumptions.

This article describes an optimized simulator, based upon a combination of the more desirable features of these design philosophies, which tends to avoid the pitfalls inherent in either. The approach is based on synthesizing, to a high degree of accuracy, the signals in a real-life situation. By generating actual signals, the need for mathematical models is eliminated. At the same time, since these signals occur in real time and at real power levels, a high degree of realism is achieved. It is undesirable to generate the actual transmitted power levels (megawatts); however the dynamic range of received power is faithfully synthesized. The signals, generated at i-f frequency, consist of the complete electronic environment of an overall field configuration, including a radar system equipped with ccm devices and targets carrying jamming equipment. In addition, a comprehensive data handling and display section is provided. Any one of a wide variety of radars, such as search, monopulse, conical scan and bistatic may be simulated. Electronic countermeasures simulation includes barrage and spot jamming, swept frequency jammers of various speeds, false target generators, range gate capture deception generators and others.

A starting point in analyzing the factors affecting target realism is the radar equation expressing the



Typical ppi display generated by the simulator under noise jamming

Radar target generator closely simulates the returns that would be received in a real life situation. Signals at i-f frequency are injected into a real radar set. Scintillation and jamming signals are included

Reproduces Jamming, Scintillation

power at the receiver as a function of target and radar parameters

$$P_{rec} = \frac{P_r G_r^2 \lambda^2 \sigma}{(4\pi)^3 R^4}$$

where P_r = radar peak power output, G_r = radar antenna gain, λ = wavelength, R = target range and σ = target cross sectional area.

Antenna gain, G_r, is the gain in the target direction and is a function of radar azimuth and elevation. Cross-section σ is the composite effect of target size, aspect and scintillation. The $1/R^4$ factor includes range attenuation on the outbound and return legs of the radar-target path. All other parameters are fixed for a radar and may be treated as a power-level calibration.

Figure 1 is a simplified diagram of the target generator. The position of the target relative to the radar site is generated in the target coordinate generator. The target is maneuvered by controlling turn rate, airspeed, and climb and dive rate. Primary outputs are azimuth, elevation and slant range, generated as shaft positions. Synchros and potentiometers on the shafts transmit coordinate information to other modules. The antenna position generator consists of two servo loops simulating antenna azimuth and elevation. Antenna scan rate is variable from 3 to 30 rpm. A manual control provides antenna tilt adjustment. The azimuth pattern generator computes the azimuth angle of the target relative to the main lobe of the antenna, using synchro information obtained from the target coordinate generator and antenna position generator. The value of the radar antenna pattern in the target direction is computed as a d-c analog, employing an electromechanical function generator of high resolution. Main and side-lobe coverage over 360 degrees is included.

D-c voltages proportional to target and antenna elevation are applied to the elevation pattern generator, where the value of the antenna elevation pattern in the target direction is computed. A diode function generator generates the cosec^2 pattern of search radars. The two-way range attenuation function, $1/R^4$, is obtained as a d-c analog from a profiled potentiometer on the target-coordinate generator slant-range shaft. Variations in target size due to the angle of observation are obtained as a function of the angular difference between target azimuth and heading (aspect angle) in the target aspect generator. Aspect angle is transmitted to this unit in synchro form from the target-coordinate generator.

The target scintillation analog is obtained by applying the output of a wide-band gaussian noise source to a narrow bandpass filter. Target size, radiated power, and frequency factor analogs are obtained by the settings of calibrated

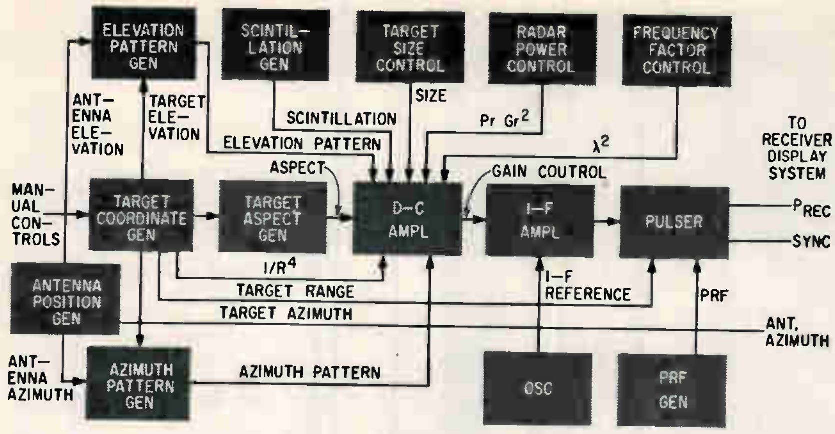


FIG. 1—Target generating complex provides realistic radar return signals for injection at receiver intermediate frequency

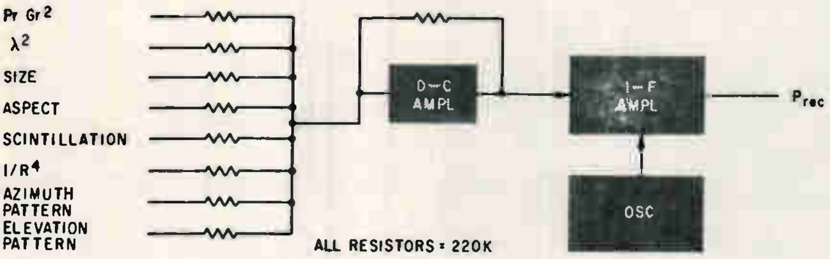


FIG. 2—Summing amplifier is used to modulate i-f amplifier in accordance with radar equation

potentiometers.

Modulation proper is accomplished in a gain-controlled i-f amplifier. The amplifier stages are biased to provide unity gain in the absence of an external gain-control voltage. Amplifier gain, expressed in db versus external gain-control voltage, is linear within ± 2 db from 0 to -120 db. The scale factor is -5 v per -120 db. The i-f input of the amplifier is at a constant level corresponding to the maximum signal strength that may occur in the system. The dynamic range of system parameters is: $Pr = 100$ w to 10 megawatt, range = 5 to 200 miles, target size (σ) = 0.1 to 100 sq. m., antenna gain = 0 to 40 db and frequency = 1 to 10 Gc.

Inserting values for minimum range and frequency, and maximum antenna gain, target size and radar power into the equation yields the maximum value of P_{rec} as -1.9 dbm. The i-f input to the amplifier is held at this value.

The analogs of target parameters are added in a d-c summing amplifier as shown in Fig. 2. Value of any analog is 0 volts for the condition that yields maximum target echo power. Each analog expresses in volts the number of db's by which the receiver signal strength is below its maximum value, with a scale factor $+50$ v per -120 db. Summing amplifier output is the gain-control voltage of the i-f amplifier. Since the i-f amplifier scale factors is -5 v per -120 db, a ten to one attenuator is inserted at the i-f amplifier input. Thus the effects of d-c amplifier drift are reduced by a factor of ten. Due to the logarithmic (db per v) amplifier characteristics, i-f amplifier output is proportional to the products of the parameters represented by the inputs to the summing amplifier. This fulfills the radar equation, including multiplication of the parameters on the right hand side. The i-f amplifier output is gated according to range in a pulser synchronized with the system prf.

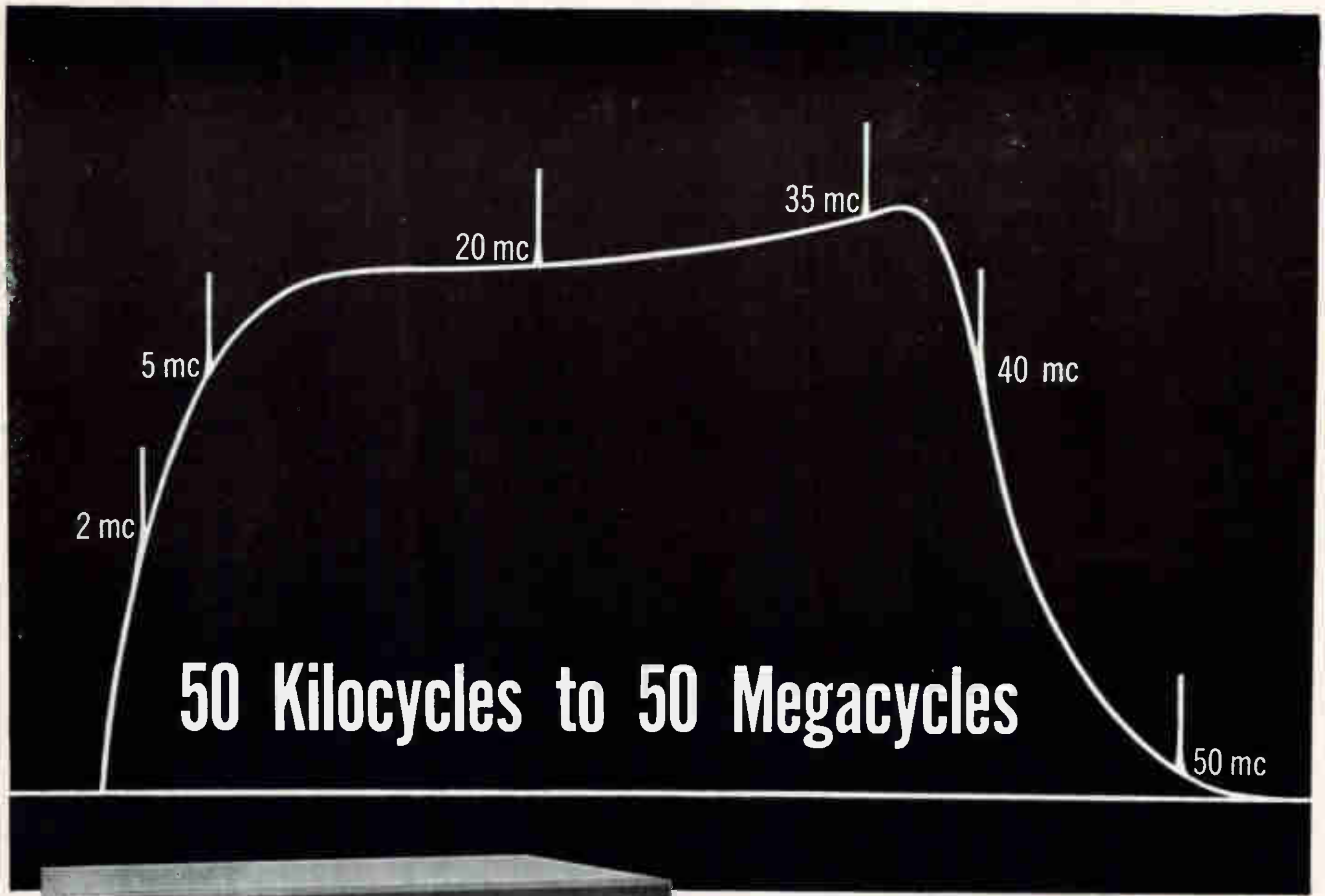
To illustrate modulation, assume a 5-megawatt radar at a frequency of 2,000 Mc and an antenna gain of 40 db, and a target with a maximum size of 50 sq. m. at an attitude relative to the radar such that the actual reflectivity is 6 db less than the maximum reflectivity. The target is located at 20 miles slant range and, at a given instant, its position relative to the radar antenna beam is: in azimuth the target is illuminated by a part of the beam that is 15 db below the peak of the main lobe in the two-way pattern; in elevation the target is at a point 6 db below the peak of the two-way elevation pattern.

These conditions define the input voltages to the summing amplifier; the analogs express (with a scale factor of $+50$ v per -120 db) the number of db by which the respective parameters are below the maximum. Thus: $P_rG_r^2 = -3$ db $= +1.25$ v, $\lambda^2 = -6$ db $= +2.5$ v, $1/R^4 = -24$ db $= +10$ v, $\sigma = -3$ db $= +1.25$ v, aspect $= -6$ db $= +2.5$ v, azimuth pattern $= -15$ db $= +6.25$ v, elevation pattern $= -6$ db $= +2.5$ v.

Scintillation is superimposed as a random variation on the signal strength. The amplitude and spectrum are functions of radar frequency and type of target. The summing amplifier output, neglecting scintillation, is 26.25 v (-63 db). Since the maximum signal strength is -1.9 dbm, the signal strength will be -64.9 dbm. The same value may be obtained by direct substitution into the radar eqution. Similar modulating techniques generate ecm signals at accurate power levels.

Operating equipment using these techniques has been constructed and used. While there are no absolute criteria for evaluating the faithfulness of a simulated radar presentation, observers familiar with ppi and A-scope displays showing targets equipped with jammers, have commended the reality of the simulator results. A pictorial library exists of evluation problems which have been run, but these are classified. However, a typical ppi display generated on the simulator under noise-jamming is shown in one of the photographs. The sidelobe structure of the antenna is displayed. The sector coverage changes with range and simulated jammer power adjustment, and target burn-through (the point where the jammer is no longer effective) does occur at close ranges.

Summarizing, the simulator generates target and ecm signals at actual receiver power levels and at i-f frequency. The modulation method permits a direct synthesis of the radar equation and all parameters affecting signal strength. The resulting simulator is a highly effective evaluator and an excellent training aid.



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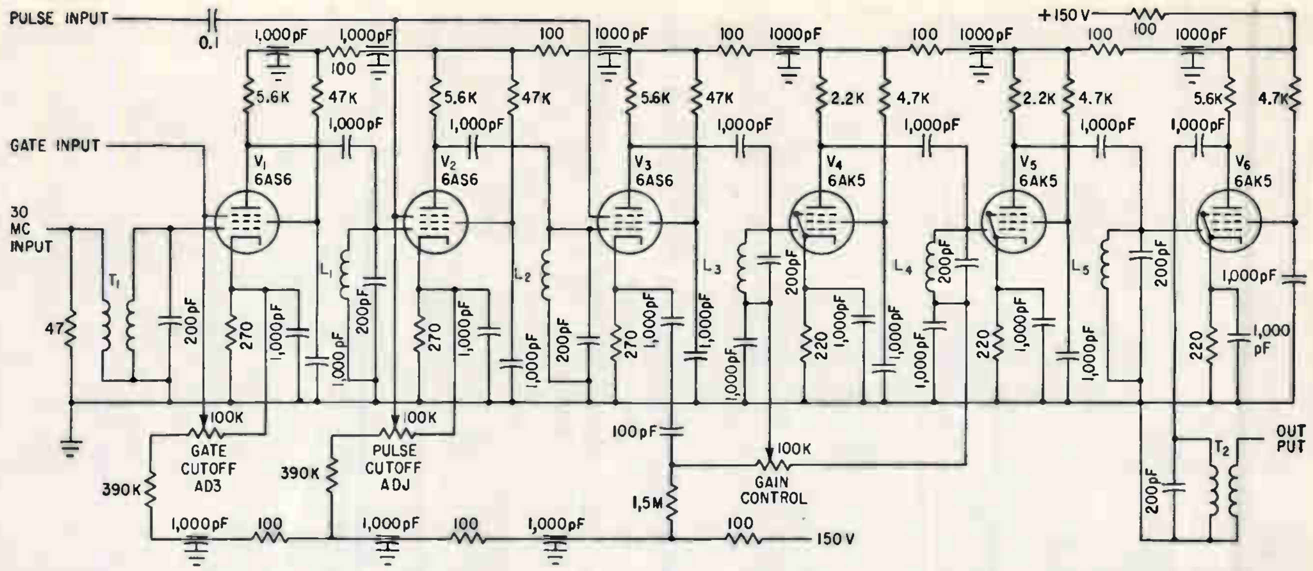


Control signals are fed to the suppressor grids of the early amplifier stages; the circuit can pass 2-microsec pulses

Suppressor Gating for I-F Amplifiers

By C. DOUGLAS RASMUSSEN
Syracuse University Research Corp., Syracuse, New York

IT IS OFTEN desirable to generate groups of i-f pulses with good signal-to-noise or signal-to-feed-through ratio, because such pulse groups simulate radar scanning and test the transient response of i-f circuits. Many signal generators have provisions for pulsing, but only the more elaborate ones provide for gating-out a pulse group. Other drawbacks to using commercial signal generators include poor signal-to-noise ratio, and limited prf and pulse width variation.

An i-f amplifier can easily be constructed or modified so that a pulse applied to the suppressor grid of a pentode will cause conduction. If an i-f signal is applied to the control grid and the suppressor grid is biased to cut off, the tube will conduct when a positive pulse of sufficient amplitude is added to the suppressor bias. Better isolation is obtained if two or three pentodes are pulsed in cascade. Similarly, two or three pentodes can be pulsed or gated at a different rate to simulate a scanning signal. The simulation of a pulsed-scanning signal is obtained by combining both groups of pentodes. An electronic counter could also be used on the output of the pulsed channel, to control the gating channel so as to pass a controllable number of pulses.

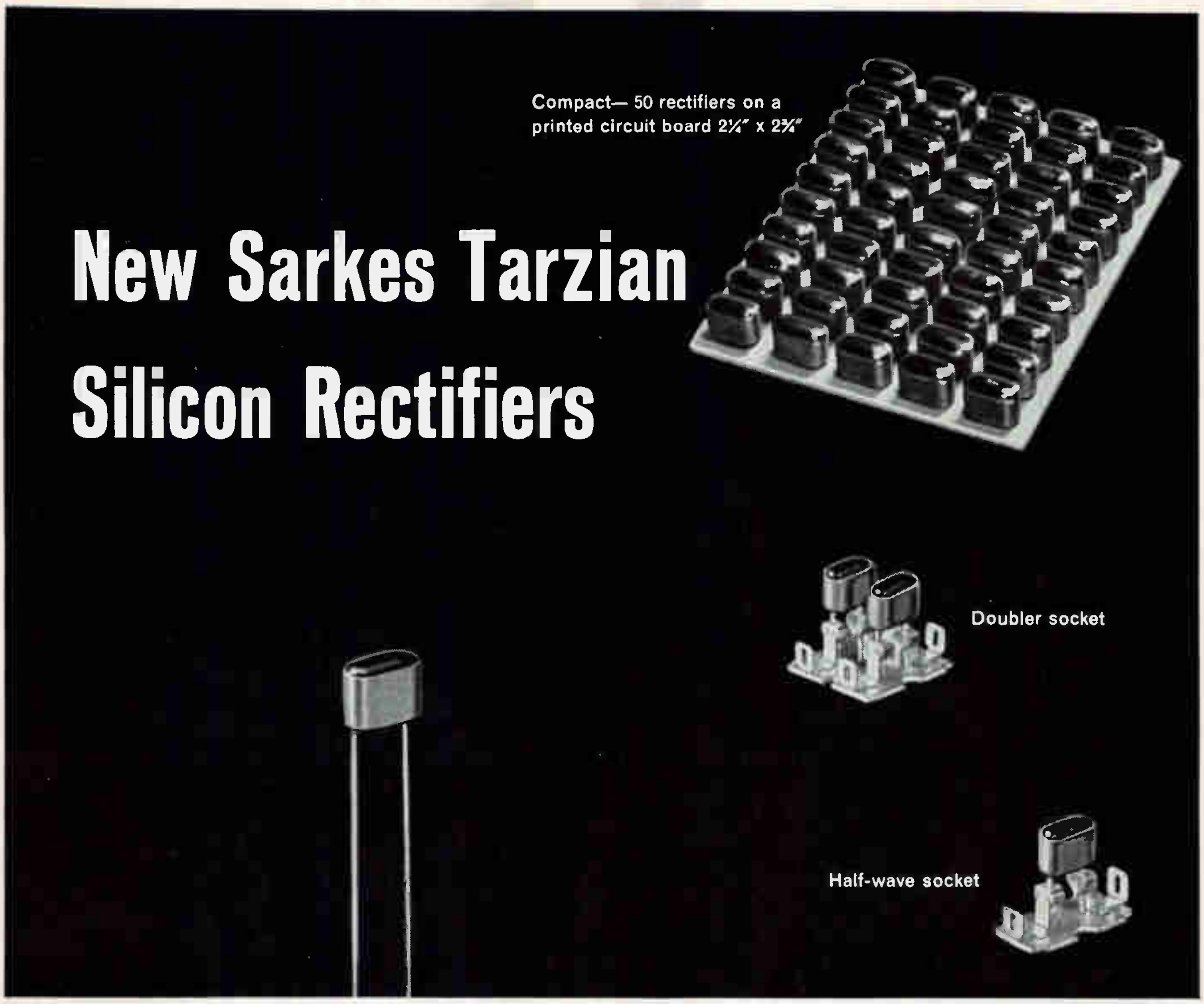
The schematic of a pulsed-gated amplifier for laboratory use is shown. It has a bandwidth of 1.2 Mc at its 3 db points, with a 30 Mc input signal of 0.5 to 2 v p-to-p. An input pulse of 5 to 50 v p-to-p in the pulsed mode will produce an i-f pulse with a signal-to-noise ratio of 43 db, but in the pulsed-gated mode using the same amplitude gate the overall signal-to-noise ratio is 26 db. This is because two i-f stages are being pulsed and only one is being gated. Pulse widths down to 2 microseconds and pulse repetition frequencies up to 150 Kc produce the best results. In the c-w, pulsed and/or gated modes the maximum variable gain is 14 db with input and output impedances of 50 ohms.

Two separate pulse generators or a dual output pulse generator and an external power supply are needed for circuit operation. Power requirements are: +150 v d-c at 50 ma, −150 v d-c at 0.5 ma and 6.3 v at 1 amp.

The Pulsed-Gated Amplifier is a 30 Mc i-f amplifier with provisions for external application of a variable negative bias to the suppressor grids of V_1, V_2, and V_3. This need not be a variable bias when the same amplitude positive pulse or gate is used. A minimum negative bias of approximately 8 volts is needed to completely cut off these tubes, and because V_2 and V_3 are pulsed in cascade, they have a common bias separate from that of V_1. A negative variable d-c bias of from 0 to −10 volts applied to the control grids of V_4 and V_5 acts as a gain control.

Due to the electrical isolation created with the cascade pulsing of V_2 and V_3, the signal-to-noise ratio of the pulsed mode is superior to that of the gated or pulsed-gated modes. The usual application calls for greater use of the pulsed mode, and, therefore, the better signal-to-noise ratio in this mode is desirable. This configuration can be revised to meet individual requirements. For example, V_1 V_2 and V_3 can be pulsed or gated in cascade, thereby further improving the signal-to-noise ratio. Or if a pulsed i-f signal is available, V_1, V_2 and V_3 can be gated in cascade.

Transformers T_1 and T_2 and coils L_1 through L_5 are wound on a CTC No. PLS 9 coil form with No. 22 enamel wire. The three turn primaries of T_1 and T_2 are wound over the five-turn secondaries.



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Snaps Connect Breadboard Circuits

By W. L. EMERY,
T. C. M. Visiting Professor,
Indian Inst. of Technology, Kharagpur, India

TEMPORARY circuits can be assembled rapidly into compact package for laboratory experiments or educational demonstrations. The assembled circuits are structurally rigid and layout generally resembles that of a final soldered circuit. Parts are connected electrically with snap fasteners that also provide mechanical support.

The flexible circuit building system is based around a basic frame. A wide variety of tube and transistor sockets are mounted on interchangeable plates, and the selected plate is attached to the basic frame. In Fig. 1, a seven-pin miniature tube socket plate and a triple-transistor socket plate are shown, as well as a dual-transistor socket plate mounted in place on the basic frame.

The basic frame and socket plate together form a foundation that holds the other components. In most cases, the components snap directly on connections at the socket, minimizing lead length and the possible adverse effects that long leads could have on circuit performance. The orderly appearance and accessibility of connections can be seen in the typical assembled circuit in Fig. 2. The circuit is a transistor multivibrator, which is shown schematically in Fig. 3.

The number of resistors required for a complete system is limited by mounting five resistors connected in series in a single holder. The five resistance values are chosen so that the thirteen standard 10 percent resistances within a decade can be obtained by some combination of the five resistors. Thus each decade of resistance values is provided by a single resistor box like those shown in the foreground of Fig. 4 with other component packages.

The resistor box was made in a triangular shape to limit bulk, to provide mechanical strength to the assembly and to avoid locating connections where they might interfere with each other. An open side in the box enables quick selection of the desired resistances.

The two-dimensional drawing of the interior of a resistor box in Fig. 5 indicates the arrangement of the resistors. Five resistances are not provided in the exact nominal standard values, which usually makes little difference. If required, however, all resistances will be within 10 percent of the nominal value if 5 percent resistors are used for 18 and 47 within the particular decade. In all but two cases, the desired resistance can be obtained simply by making connections to the appropriate terminals on the box. To obtain either 39 or 68, one external jumper is required to shunt out unwanted resistors.

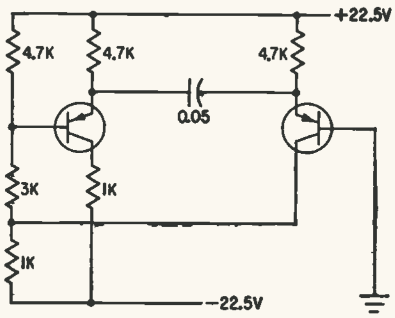


FIG. 3—Three resistors forming voltage divider at left of multivibrator circuit can be provided by one resistor box

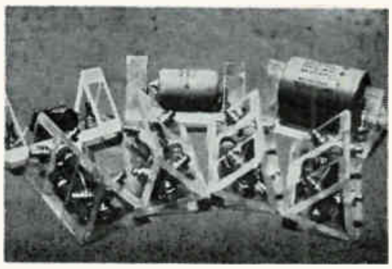


FIG. 4—Components are mounted in standard size triangular package

A single resistor box can sometimes provide several resistance values. For example, the three resistors at the left in Fig. 3 can be obtained from one resistor box. By connecting a jumper across the 1,500-ohm resistor, the sum of the 1,800-ohm and the 1,200-ohm resistors in series provides the required 3,000 ohms.

Capacitors are mounted individually in open-faced triangular boxes having the same dimensions as the resistor boxes. Although three capacitors had been mounted together in single boxes, this approach was abandoned because it seemed to offer no advantage in practice.

By extending the general construction pattern to other circuit elements, such as high Q inductors, variable capacitors and i-f transformers, any of a wide variety of medium frequency circuits can be

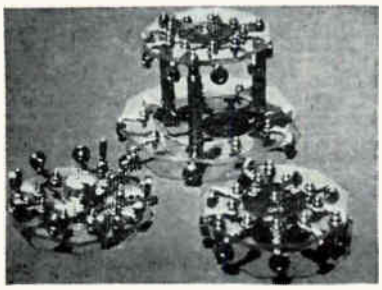


FIG. 1—Typical socket plates are shown with one plate in place on basic frame

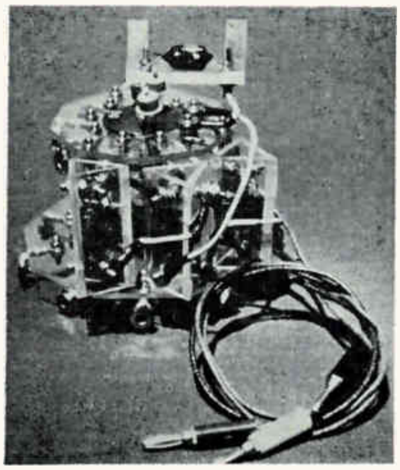
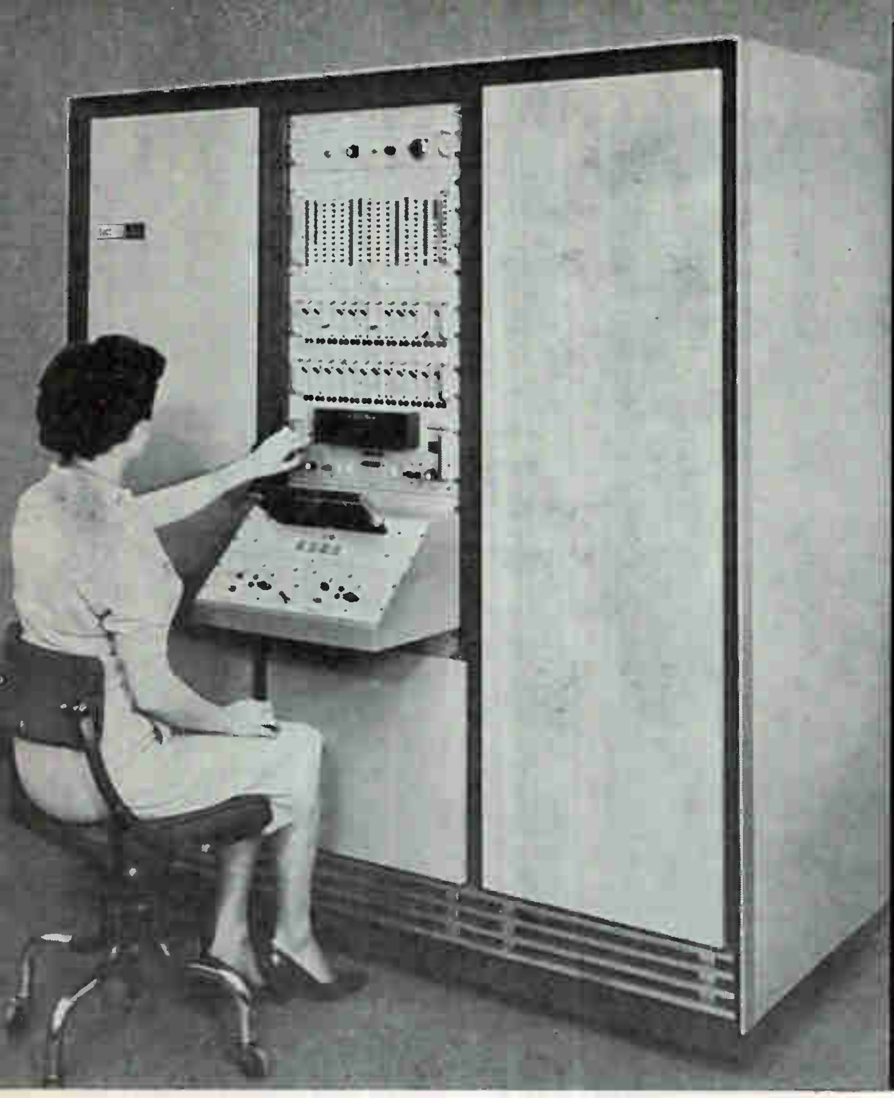


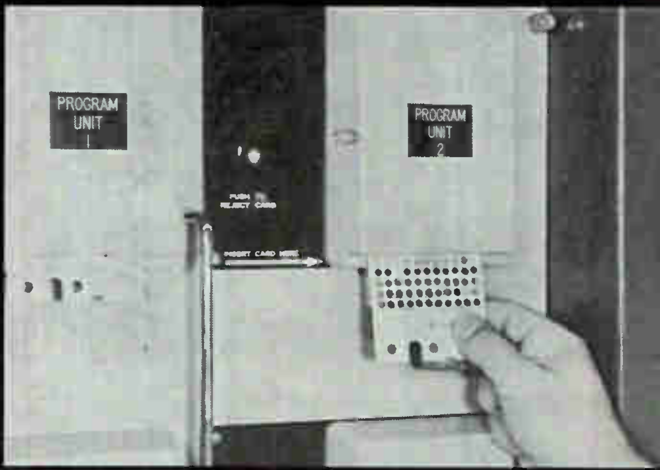
FIG. 2—Assembled multivibrator circuit has orderly appearance



new from TI

tact

TRANSISTOR AND COMPONENT TESTER



Fast, Simplified Programming
With Punched Cards

MAXIMUM VERSATILITY *PLUS* ECONOMY

tact BUILDING-BLOCK DESIGN GIVES YOU BOTH!

TACT is a universally applicable transistor and component tester that will meet both present and future requirements without undue investment. It is a sequentially controlled system which advances through as many as 24 test parameters, applying pre-programmed test limits and visually reading out and/or recording measured results. Time-proved test circuitry is combined with punched-card programming to produce a highly accurate system of high sequential testing speeds.

TACT systems won't become obsolete—can be expanded to accommodate future tests or extended to testing printed circuit boards, modular circuits, etc.

High Testing Accuracy results from reduction of readout and signal cable leakage and interference. Test circuitry cabling has been reduced to approximately one-tenth of other designs offering similar testing capabilities.

Repeatability of Testing is maximized by punched-card programming and remote control of common test circuitry. Program cards can be retained and used indefinitely, assuring high repeatability and a permanent record of test conditions.

Nontechnical Personnel can operate TACT systems with minimum training. Reprogramming can be accomplished in minutes without circuit board or plug-in unit changes.

APPARATUS DIVISION
PLANTS IN HOUSTON
AND DALLAS, TEXAS

TEXAS INSTRUMENTS
INCORPORATED
3609 BUFFALO SPEEDWAY
P. O. BOX 6027 HOUSTON 6, TEXAS

CIRCLE 65 ON READER SERVICE CARD

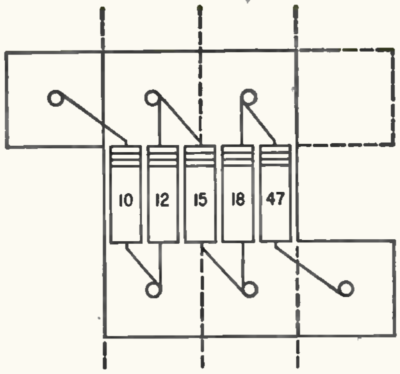


FIG. 5—Inside view of resistor box shows five series-connected resistors that provide thirteen resistances within decade

assembled in minutes.

Careful attention must be given to some constructional details to ensure strength and durability. Experience indicates that the snap fasteners used on the connecting leads require reinforcement at the junction between the solder tab and the body of the snap. Breaking at this point is much less likely if the cross section is built up with a liberal flow of solder. The point where the wire joins the solder tap also requires added strength, which can be obtained by extending the braid covering on the wire under the first clamping tabe in the wire holding lug.

The snap connectors around the bottom edge of the basic frame and around the socket plates are subject to heavy mechanical strain. The necessary mechanical strength can be obtained for these parts by shaping a cotter pin from a piece of #12 solid copper wire. The solder lug of the snap fastener is bent at a right angle relative to the face, and the shank of the cotter pin is firmly clamped and soldered into the lug. The resulting structure has been found capable of withstanding considerable abuse.

Finally, accidental short circuits between adjacent snap fasteners can be avoided by covering the lug with plastic tubing.

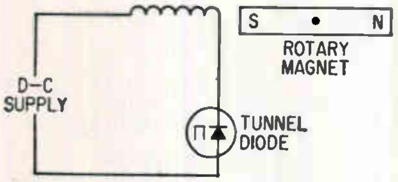
The author acknowledges the assistance of Robert Newbold, who participated with the author in producing the first version of the system at the University of Utah, Gener Leichner and J. V. Ranga Rao, who suggested improvements, and S. Dutta and A. Sengupta, who did the construction for the present system.

Tunnel Diode Operates Brushless D-C Motor

By H. E. STOCKMAN, Prof. E.E., Lowell Technological Inst., Lowell, Mass.

TUNNEL diode can be substituted for a transistor in an electronic watch or clock. The tunnel diode not only has one fewer electrode but provides further simplification by eliminating one of the windings used in present electronic watches.

The basic device, which is covered by a patent application, is a tunnel diode d-c motor that can provide either rotary or pendulum motion. The simple d-c motor shown in the schematic diagram requires no commutator or brushes. It is comprised of three basic elements: a single winding, a rotating magnet and the tunnel diode.



Tunnel diode permits operation of simple d-c motor without commutator or brushes

To provide pendulum motion, the device starts itself. Slight deflection of the rotary magnet when power is turned on is enhanced regeneratively building up oscillatory motion to full pendulum swing.

Present models of the device were fabricated by Sine-Ser Co., Waltham, Mass., solely for educational purposes. However, some of the characteristics of the tunnel diode motor suggest a variety of potential applications.

The absence of any kind of moving contacts in the d-c motor should reduce maintenance problems. Resistance of tunnel diodes to nuclear radiation would be advantageous in environments where radiation level is high.

Input power for the small motors could be provided by most of the newer d-c power sources including thermoelectric generators and solar cells. The demonstration models of both rotary and pendulum types of the tunnel diode motor are operated from a single standard flashlight cell.

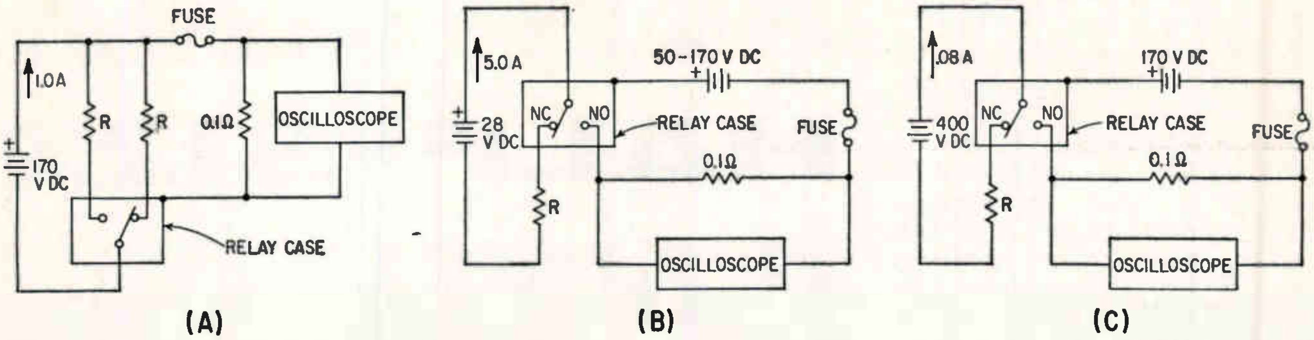


FIG. 1—D-c circuits used in relay tests. In A there is a po sitive case ground, arc life is adjusted to 1.5 msec average. B is for effect of auxiliary circuits, and C is a glow dischar ge circuit

Catastrophic Relay Failures

THE CURE: CIRCUIT DESIGN AND TESTS

By CHARLES P. NUNN
REINHOLD HOLBECK
Filtors, Inc.,
Port Washington, N. Y.

THE NATURE of the transient discharge phenomenon in miniature relays was described in this column last week. This article describes the design precautions that should be taken to avoid catastrophic relay failures and gives recommended test procedures for circuits with grounded-case relays.

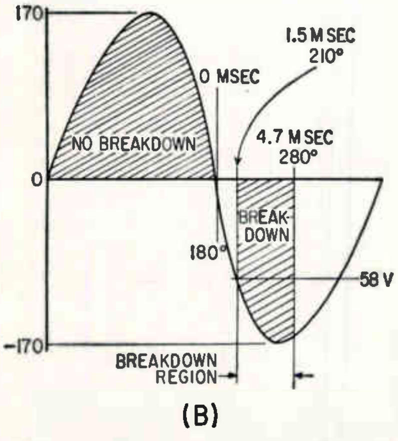


FIG. 2—Discharge in circuit A on a 60-cycle, 2 ampere, resistive, a-c load. Waveform (B) is taken at point X of circuit A.

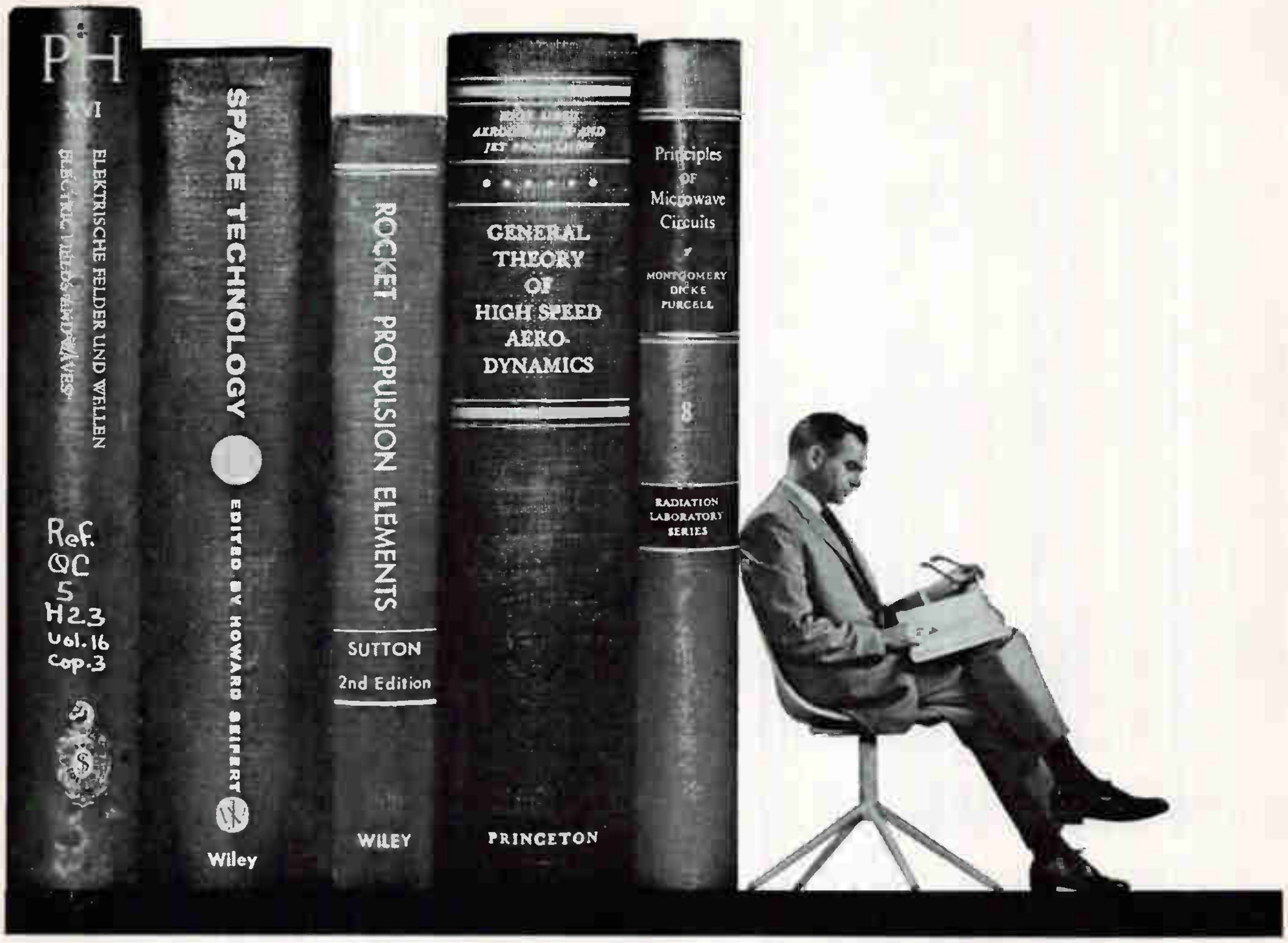
Filtors study of the transient discharge phenomenon showed that catastrophic failures occurred when the relay case is grounded and the contacts are used to switch more than 0.5 ampere and 50 volts. The findings for a-c and d-c loads correlate.

In the test circuits used in the d-c test, Fig. 1, a Tektronix 535 oscilloscope was used to determine the arc life across the opening contacts and the current peak in the ground circuit when a discharge occurred. It was found that fairly consistent results could be obtained with these circuits. A minimum potential difference between the relay contact and case was found to exist. Below 50 volts, a discharge to the relay case did not occur. Another empirical relation found by using d-c sources was that the arc life on the separating contacts had to be in excess of 0.5 to 1.0 millisecond. This figure was obtained by using resistive loads of rather high current and low voltage and the circuit shown in Fig. 2B; for example. a 5-ampere resistive, 28-volt, d-c load. It should be noted that a higher potential between the contacts and case was required as supplied by the auxiliary circuit.

Another circuit was constructed using an inductor and a series resistor in order to determine the effect of the inductive loading. When the contacts were opened, an arc formed which was usually followed by a short glow discharge. When the arc life was in excess of 0.5 millisecond, an arc discharge to the relay case was encountered when the potential difference exceeded 50 volts. Next, a high-voltage, low-current power supply was used to determine if the discharge to the relay case would occur when a glow discharge across the opening contacts was present, Fig. 1C. The contact load for this test was 80 milliamperes resistive, 400 volts, d-c and a 170 volt, d-c potential difference was established between the relay contact and case. No indication of an arc discharge to the case was noted, although the opening contacts exhibited a glow discharge.

Under the a-c arcing condition previously described (2 amperes resistive, 115 volts rms, 60 cps), the initial breakdown always occurred when the grounded relay case was positive with respect to the contacts. D. Saewert of Motorola, Scottsdale, Arizona, has shown, through a statistical treatment of synchronized a-c voltages, that the discharge always occurs on the negative half of the a-c cycle. Figure 2 shows the approximate values that were found using synchronized a-c voltages.

Tests with direct-current loads at



scientists and engineers in a unique leadership role

The frontiers of space science and technology are being expanded at Aerospace Corporation. The scientists and engineers of this leadership organization are the critical civilian link uniting government and the scientific-industrial team developing space systems and advanced ballistic missiles. In providing broad scientific and technical leadership to every element of this team, they are engaged in a balanced program of activities spanning the spectrum from basic research and forward planning through general systems engineering. Included in the latter are technical supervision, integration and review of the engineering, development and test operations of industry to the extent necessary to assure achievement of system concept and objectives in an economical and timely manner. These people are privileged to view both the state-of-the-art and system development in their totality. Now more men of superior ability are needed: highly motivated scientists and engineers with demonstrated achievement, maturity, and judgment, beyond the norm. Such men are urged to contact Aerospace Corporation, Room 110, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

Filtors, Inc., show a close agreement with both the potential and the arc times found by Motorola. A circuit, Fig. 1A, was constructed where the relay switched a 170-volt, d-c, resistive, 1-ampere load. The breaking arc life was approximately 2 milliseconds. A discharge was encountered when the relay case was connected to the positive side of the supply and the contacts were located in the ground leg. No discharge was encountered when the relay case was connected to the negative side of the power supply (common type of industrial grounding) and the contacts were in the positive leg.

The conclusion from these tests closely match that which could be predicted by the hypothesis. It should be mentioned that under certain extremely heavy arcing conditions, a discharge could be obtained with opposite polarity. This is probably due to saturation of the atmosphere with ions and metallic vapors which would not normally be encountered. Additional studies are being performed along these lines.

After the performance of existing crystal case relays had been established and the breakdown mechanism determined, the remaining design problem was the construction of a relay that would meet the load requirements. Due to the mechanism of the breakdown, there seemed to be many approaches open for corrective action. The most logical approach to the problem appeared to be to investigate design changes in the relay switching circuit plus insulation of critical metal parts. In the relay design that finally evolved, the switching circuit was reoriented, placing the ground potential pole pieces further away from the switching circuit. The actuator, header and relay housing are all protected by insulation. The Pillbox relay designed was tested to switch 2 amperes at 115 volts 60 cycles, and no discharge has occurred in the 100,000 operation life span.

It is strongly recommended to relay users that their internal testing specifications call out the fusing of the ground circuit when relays are subjected to power load life tests.

It has been found that a 0.1 ampere or a 0.25 ampere fuse between the relay case and ground permits discharge current to build up to about 40 amperes before the fuse ruptures. Forty amperes will damage the relay but will not destroy it.

Ceramic Materials For Microwave Applications

SINCE there are a very wide range of microwave devices for which ceramic techniques can be considered, a whole area may be opened up for strong ceramics that possess high dielectric constants and low-loss tangents.

G. B. Walker of the University of British Columbia suggests titanium dioxide with a flux, magnesium titanate, alumina and beryllia. With titanium dioxide a dielectric constant up to 100 btu can be obtained and it is possible to adjust the constituents to achieve any desired values in the range from one to 100. Walker recently discussed two structures: an electron linear accelerator and a millimeter wave traveling wave tube.

The applications he envisages must remain proposals until adequate evidence on reliability has been obtained from comprehensive laboratory tests.

The most important practical considerations have to do with the behavior of ceramics under electron bombardment.

Coaxial Cable Exhibits Minimum Phase Shift

NEW TECHNIQUES for producing coaxial cable with a phase shift of only 20 parts per million/deg C, within the range of 10 to 32 C, suitable for any coaxial cable design utilizing polyethylene dielectric was recently announced by Times Wire and Cable, division of The International Silver Co., Wallingford, Connecticut.

Normally coaxial cable exhibits a 200 parts per million/deg C phase shift over this temperature range. Major applications at present include radar and sonar, where sending and receiving signals must be compared with minimum variable introduced by the coaxial cable.

The new technique conforms to the electrical and environmental requirements of MIL-C-17C.

Contact Pattern Aligns P-C Matrix

By LAWRENCE J. KAMM,
Design Specialist,
General Dynamics/Astronautics,
San Diego, Calif.

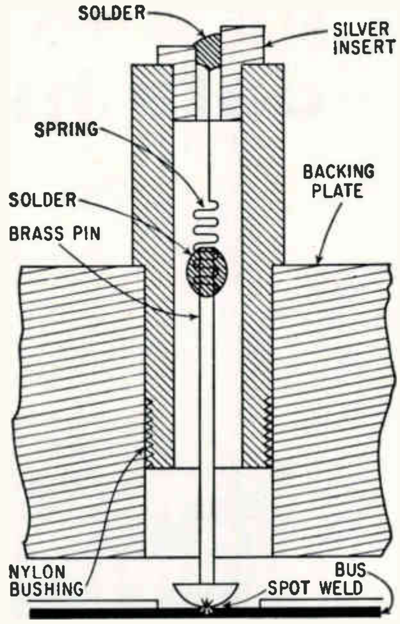
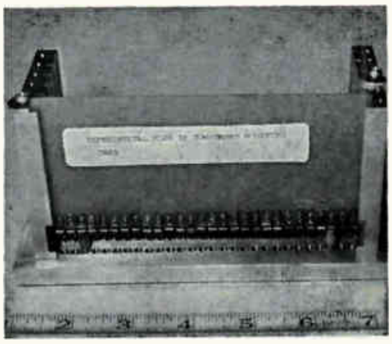


FIG. 2—Terminal provides flexible coupling to bus



Contact springs along bottom of plug-in card press against terminals in experimental setup which could be used for amplifier interconnection

SIMPLE, RAPID, but accurate methods of producing connections in a printed circuit matrix were devised during development of the air-operated analog computer problem connector reported last week (ELECTRONICS, p 64, Aug. 18, 1961). The matrix contains more than 5,000 possible connection points.

Connections are made when flexible printed circuits, carrying horizontal and vertical buses, contact each other through holes in a Mylar punched card. One such connection is shown in Fig. 1. Construction of the terminals is detailed in Fig. 2. The major production problems encountered during development were maintaining alignment of connections, achieving flexible contact with terminals and welding the terminal contacts to the vertical buses.

Alignment is assured by two general methods. The fabrication pattern for all major parts and production templates is the master pattern for the printed circuit contacts. Before any part is produced, alignment holes are made in the film positive and part blanks. Whenever any two parts are put together for any operation, alignment is established by dowels through these holes.

A film positive of the printed circuit contact pattern is used to apply electroplating resist to the laminates. The mating contact spots are plated with gold or rhodium on top of silver, copper or other suitable metal. A bus pattern is made from a print of the contact film positive. The plating resist is stripped, etching resist is applied and the bus pattern is produced on the printed circuit sheet.

The same contact pattern film is used for both printed circuits. Even if the pattern is geometrically imperfect, the two printed circuits will be in alignment and all contacts and terminals will have nearly perfect registration. One side of the film is placed against the vertical bus blank while the other side of the film is placed against the horizontal bus blank.

An enlarged portion or island, consisting of a $\frac{1}{8}$-inch disc, is formed in the bus for each terminal connection. A contact pin is spot-welded to the underside of the bus at this island, through a hole burned in the underlying plastic (Fig. 2).

The holes are burned by an oxy-hydrogen flame, applied by torch through an aluminum template. During burning, the template shields the remainder of the plastic. A second aluminum plate, placed against the other side of the printed circuit, cools the conductors. It proved impractical to burn the holes with a hot iron, which caused delamination, or by machining the plastic, which damaged the copper.

The burning template also serves as the pattern for drilling the terminal holes in the backing plate, assuring alignment of the contact pins with the bus contacts. The contact pattern is printed on the aluminum sheet used for the template. This sheet is then pinned, through alignment holes, to the banking plate blank. The holes are then drilled in both.

Each terminal provides a sturdy, air-tight, external connection which can be used as a wiring terminal or a contact for plug-in resistor subassemblies. The pin and spring form a flexible coupling which permits the printed circuit to make or break contact. The pin is a standard dressmaker's pin. Its rounded head is excellent for spotwelding to the copper bus.

The backing plate serves as the welding jig. Since it was prepared with the burning template, pin positioning is positive and auto-

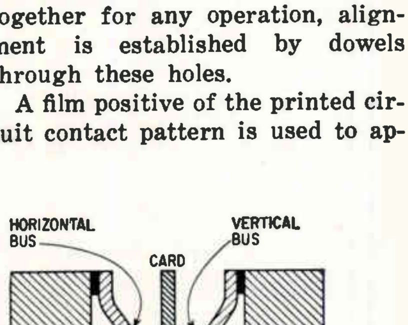
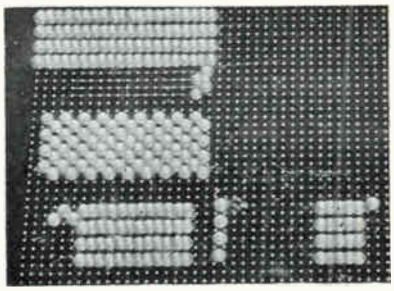
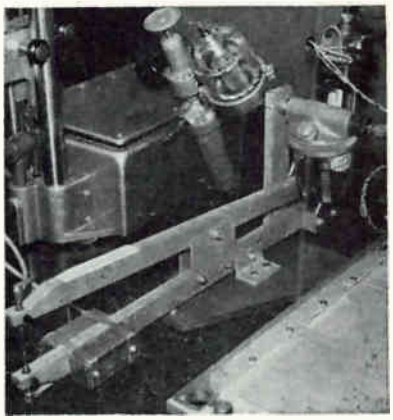


FIG. 1—Contact is made by printed circuit bus cards

matic. The printed circuit is bonded to the plate and the welds are made blind through the holes. The pin, in turn, is soldered to the spring.



Portion of a burning template



Terminal pin spotwelder

The upper electrode (copper) of the spotwelder is drilled along its axis to receive the pin. The lower electrode (molybdenum) contacts the bus. The welder's arm assembly is fully floating, to protect the printed circuit from damage, and has a deep throat so every position can be reached. A standard stored energy supply powers the welder.

Planning sheets may be used to translate a problem circuit diagram into contact locations. Reproductions of the films used to etch the buses in a pair of printed circuits are marked to show components connected to each bus. The operator also marks intersections of buses he wants to connect and uses the sheet as a guide to punching of the Mylar cards.

Three punching methods have been conceived. A guide block similar to a manual Braille punch can be used. Or, a power punch can be guided with a hole locator template. Punching can be made fully automatic by a machine which duplicates in a card hole positions indicated on the planning sheet.

Control of Moisture Improves Transistors

PRECISE CONTROL of moisture levels in hermetically sealed power transistors improves their characteristics, reports Motorola Semiconductor Products Inc., Phoenix, Ariz. The division is using, during production, a hydrate getter which produces ambients drier than those conventionally used, but not as dry as can be obtained with other getters.

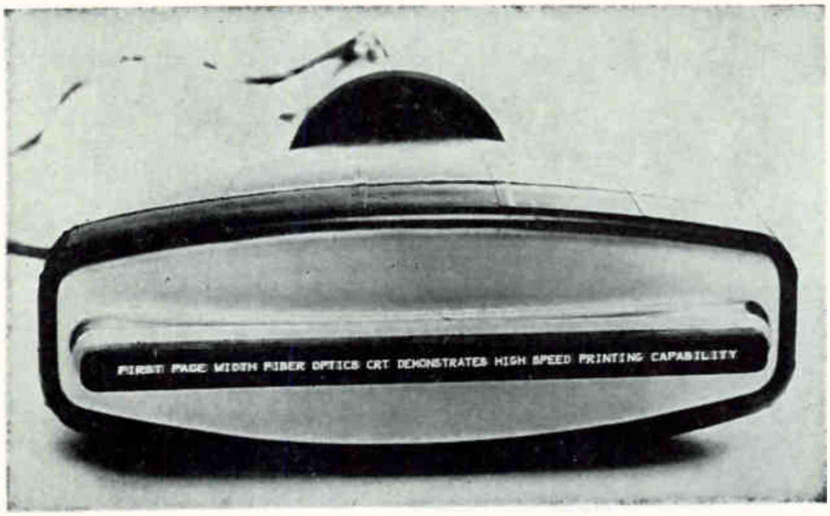
The techniques are reported to increase power gain by 3 db to 4 db and to substantially reduce low-voltage saturation currents. More than 250,000 transistors produced show closely identical properties and low failure rates, the company said.

Investigations of semiconductor surface sensitivity to ambient moisture show serious degradation of performance when semiconductors are exposed to moisture above 40 percent relative humidity at room temperature. Performance of devices subjected to lower humidities is generally acceptable, but not optimum, the report said.

It was found that barium oxide can produce partial pressures as low as 10^{-18} atm of water at 25 C, equivalent to 80 water molecules in a 2-cc transistor can. Adsorptive getters, such as molecular sieves, glass and paper fibre filters, yield partial pressures of about 10^{-7} atm, or 10^{12} water molecules per can.

But the use of barium oxide getters decreased power gain as much as 3 db and increased saturation current up to 30 microamperes. Further investigation revealed that an ambient control system employing $BaO + CaSO_4 \cdot \frac{1}{2}H_2O$ provided power gains 8 db to 10 db higher than the driest system and up to 4 db higher than regular production samples. This hydrate system, producing a partial pressure level approximately equivalent to 0.2 percent relative humidity, has been incorporated into specific production lines, Motorola said. The research is being extended to germanium mesa transistors.

New On The Market



Page-Width Fiber-Optic CRT
CHARACTRON SHAPED BEAM TUBE

CATHODE RAY TUBE uses Charactron shaped beam tube for character generation, has fiber optic faceplate 8½ inches long, half-inch wide. The fiber optics strip simplifies and improves the optical system for line-at-a-time data printing. Fiber optics techniques eliminate conventional lens systems and allow direct contact printing of data.

Fiber optics systems additionally will be compact, and will permit operation with lower deflection power and accelerating voltages. Manufacturer is General Dynamics, Information Technology Div., 1895 Hancock St., San Diego 12, Calif.

CIRCLE 301 ON READER SERVICE CARD

Magnetic Core Timer
SMALL, RELIABLE

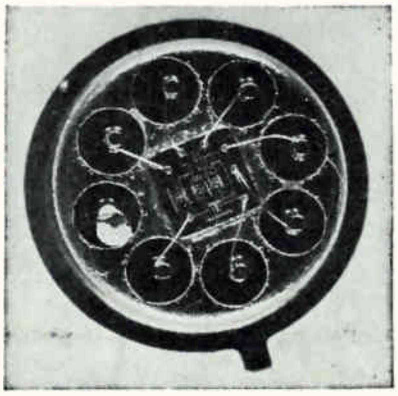
FAMILY OF TIMERS based on magnetic core oscillation is available from Minneapolis-Honeywell Regulator Co., 600 Second St. North, Hopkins, Minn. Weighing about an ounce and with 12 components, units provide time bases from hundredths of a second to 100 seconds, to 0.1 percent error from −65 to 165 F.

Controlled saturation of a magnetic core allows oscillation from 5 to 100 cps. Timers with interval to five seconds can be packaged in one cubic inch.

CIRCLE 302 ON READER SERVICE CARD

Micrologic Elements
GATE AND REGISTER

MICROLOGIC GATE and half-shift register now in volume production, can, when used with flip-flop introduced earlier, be used to build complete logic and control section of a digital computer. A 90 percent reduction in size and 70 percent reduction in cost of logic sections



using family of six micrologic elements—three to be introduced later this year—is predicted. Initial price is $120 each in small quantities from Fairchild Semiconductor, 545 Whisman Rd., Mountain View, Calif.

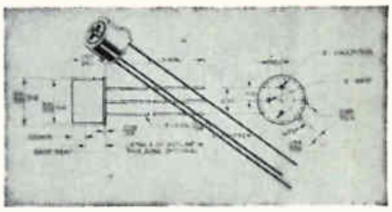
CIRCLE 303 ON READER SERVICE CARD

Digital Relay Timer
MEASURES DELAYS

DIGITAL RELAY timer has applications in production testing, incoming inspection, engineering development and maintenance. Unit consists of precision time reference and digital counter, will measure relay operate, release, travel and bounce times. Handles relays with up to 6 poles. Price is $2,295 from

Leach Corp., 18435 Susana Rd., Compton, Calif.

CIRCLE 304 ON READER SERVICE CARD



Tiny Power Transistors
LOW SATURATION

SILICON TRANSISTORS with low saturation resistance can switch up to 120 watts without using a heat sink. Series includes 2N2033, 2N2034 and 2N2035, for collector currents of 500 ma, 1 amp, and 1.5 amp, respectively; 2N2033, 2N2034 are TO-5 size, 2N2035 is TO-8. Manufacturer is Silicon Transistor Corp., Carle Place, N. Y.

CIRCLE 305 ON READER SERVICE CARD

Tunnel Diode
PEAK-TO-VALLEY OF 20:1

TYPES MS232-3-4 gallium antimonide tunnel diodes operate from −55 to 100 C, have cutoff in the 2 to 4 Gc range, noise constants 40 percent less than germanium units.

Typical peak-to-valley ratios are

16:1 and 20:1. Diodes are immediately available in limited quantities from Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J.; price range is $125 to $300.

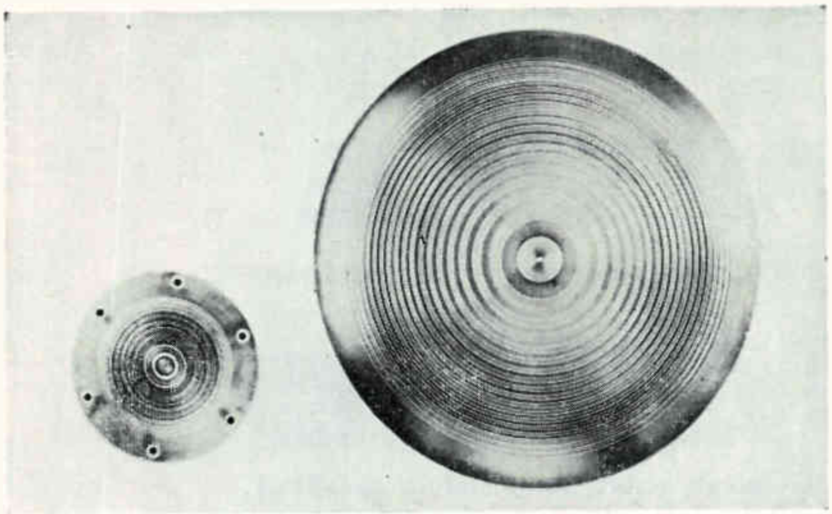
CIRCLE 306 ON READER SERVICE CARD

Epoxy Compound

LONG WORKING LIFE

MERECO PRODUCTS DIVISION, Metachem Resins Corp., 530 Wellington Ave., Cranston 10, R. I. Mereco No. 43-21 is a low viscosity epoxy impregnating and casting system designed to withstand continuous operation at extended periods at temperatures up to 500 F. It exhibits a heat distortion temperature of 148C (300 F). The system has a working life of at least four weeks, making it suitable for use in vacuum impregnating operations and laminating applications.

CIRCLE 310 ON READER SERVICE CARD



Fresnel Zone Antennas

FOR 70 TO 3,000 GC

FRESNEL ZONE PLATES, used for optical frequencies, are now available at millimeter wavelengths. Phase-correcting plates produce focusing and collimating effects similar to parabolic reflectors and dielectric lenses. Fresnel zone plate characteristics include low loss, light weight, low cost, large aperture, frequency range 70 to 3,000 Gc. Manufacturer is Electronic Communications, Inc., 1830 York Rd., Timonium, Md.

CIRCLE 307 ON READER SERVICE CARD

Transient Indicator

TO 1 μSEC PULSES

TRANSIENT VOLTAGE indicator is self contained, portable, will record voltage pulses as short as one microsecond. Includes indicator light with memory feature permitting unattended operation for as long as three weeks.

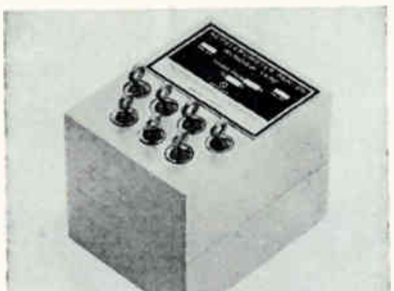
Voltage ranges are 0 to 200 and 0 to 2,000. Input impedance is 5 pf in shunt with 1 megohm. Unit is available from Vap-Air Div., 6444 West Howard St., Chicago 48, Ill.

CIRCLE 308 ON READER SERVICE CARD

Accelerometer

WINDOW TYPE

PALOMAR SCIENTIFIC CORP., 4039 Transport St., Palo Alto, Calif. Subminiature PW series force balance accelerometer is self-contained with own amplifier in 2 cu in. Servo action delivers 0.1 percent accuracy, ± 8 v output without cascaded drift typical of low-level transducer and separate amplifier. Narrow window gives high sensitivity for



close look over restricted g range. Window can be accurately offset by current command.

CIRCLE 309 ON READER SERVICE CARD

Plug-In Amplifier

LOW-COST

EMBREE ELECTRONICS CORP., West Hartford, Conn. Model C/100/M is a low-cost octal base plug-in operational amplifier for analog computer and instrument applications. Gain is over 30,000 d-c open loop with an output of 3 ma at ± 100 v d-c into a 33,000 ohm load. Output may be directly shorted without damage to the unit. Provides full ± 100 v swing to 20 Kc, with 0.6 μsec rise time with a bandwidth over 400 Kc as a unity inverter into a 100,000 ohm resistive load.

CIRCLE 311 ON READER SERVICE CARD

Transistor Sockets

TEFLON INSULATED

GARLOCK INC., Palmyra, N. Y. Transistor sockets for JEDEC TO-8 type case. Insulation material is Teflon TFE; 3 tubular type beryllium copper contacts accept nominal 0.030 diameter leads. Contact finish is silver plate 0.0003 min and gold flash 0.00002 min. Sockets are compression mounted in 0.390 diameter

hole and mounted on underside of deck with nickel plated brass saddle. They are designed to accommodate the new r-f power amplifier transistors.

CIRCLE 312 ON READER SERVICE CARD

Coil Winding Head

WALTHAM PRECISION INSTRUMENT CO., INC., Boesch Manufacturing Div., 45 River St., Danbury, Conn. Toroidal coil winding head for heavy wire buildup has a two-piece magazine which opens into halves for insertion of cores.

CIRCLE 313 ON READER SERVICE CARD

Ceramic Wire
METAL-SHEATHED

AERO RESEARCH INSTRUMENT CO., 315 N. Aberdeen St., Chicago 7, Ill. Advances in manufacturing have made possible the production of long ceramic insulated, metal-sheathed wires to close electrical and physical tolerances. Problems of sheath splits, damaged wires and insulation voids are alleviated. Special assemblies, such as triaxial and bitriaxial thermocouples are now possible and practical.

CIRCLE 314 ON READER SERVICE CARD

True RMS VTVM
¼ PERCENT ACCURACY

TRIO LABORATORIES, INC., Plainview, N. Y. Rack-mounted true rms vtvm offers direct, instant readings of a-c voltages with accuracy of ¼ percent of full scale. Model 120-7 measures both complex and sine waves with laboratory standard accuracy. Errors due to harmonics and spikes distorting the accuracy of peak and average-reading instruments are eliminated by use of a special dynamometer movement. Unit has input impedance of 1 megohm.

CIRCLE 315 ON READER SERVICE CARD

Resistivity Meter
FOR SEMICONDUCTORS

TEXAS INSTRUMENTS INC., P. O. Box 6027, Houston 6, Texas, introduces an a-c semiconductor test instrument for measuring bulk and slice resistivity. A slice adapter is available for measuring resistivity of slices ranging in thickness from 0.007 to 0.037 in. Total error involved in measuring the parameters of a silicon single crystal and slices has been reduced from ± 25 percent to less than ± 5 percent.

CIRCLE 316 ON READER SERVICE CARD

Load Cell

UNITED AERO PRODUCTS CORP., Burlington, N. J. Hysteresis error is less than 0.1 percent, temperatures range from −85 to +500 F, available in ranges from 5 to 500 pounds.

CIRCLE 317 ON READER SERVICE CARD

Tiny Potentiometer
GANGABLE TO 8 UNITS

BORG EQUIPMENT DIVISION, Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wisc. The 2490 series of single-turn Micropot pots, with a standard resistance range of from 100 ohms to 200,000 ohms, is 3 in. in diameter and 1 in. long. Resistance element is wirewound featuring certified resistance alloys wound on thermosetting cards. Maximum power rating is 6 w at 40 C.

CIRCLE 318 ON READER SERVICE CARD

Sensitive Relay
INDUSTRIAL CONTROL

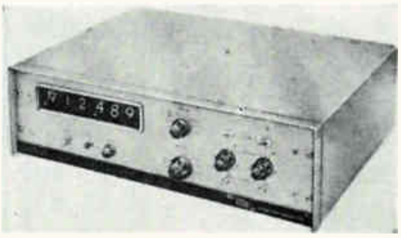
ACROMAG INC., 22515 Telegraph Road, Southfield, Mich. Industrial control relay has a sensitivity of 0.001 μw. A d-c control signal of 1 μa and 1 mv into its 1,000 ohm control winding causes the output relay to close thus controlling up to 1,800 w of 60 cps power. Input stage is a high gain toroidal magnetic amplifier. Second stage is a transistor trigger amplifier which drives the output relay.

CIRCLE 319 ON READER SERVICE CARD

Solid State Control

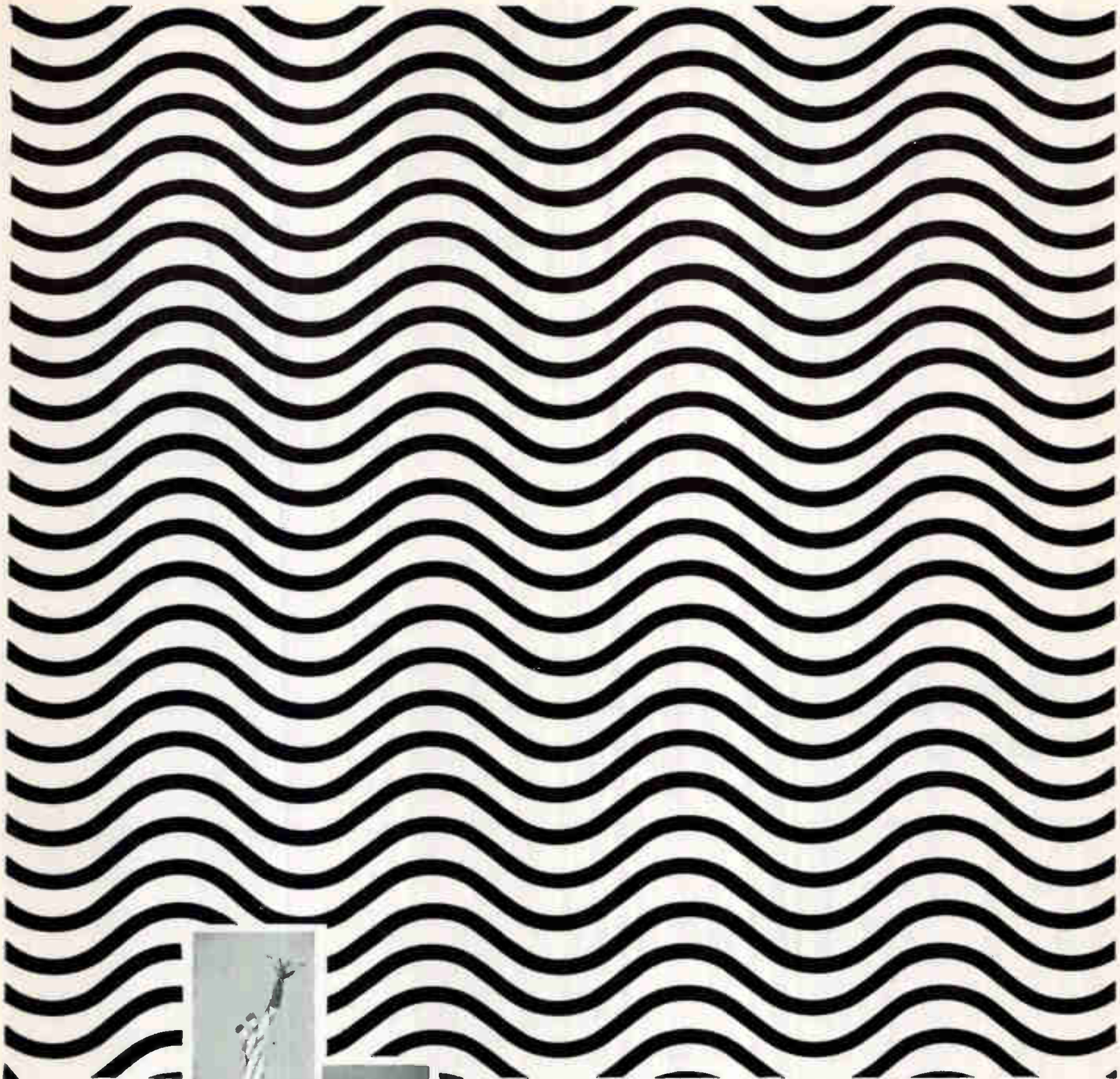
ACOUSTICA ASSOCIATES, INC., 10400 Aviation Blvd., Los Angles 45, Calif. Ultrasonic liquid-level control features solid state switch which eliminates conventional relay.

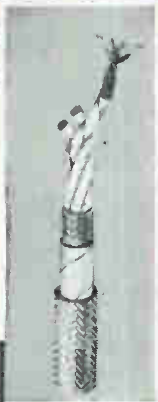
CIRCLE 320 ON READER SERVICE CARD

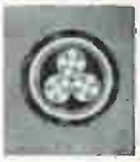


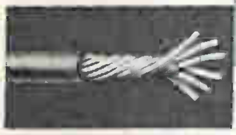
Freq/Time Digimeter
SOLID STATE

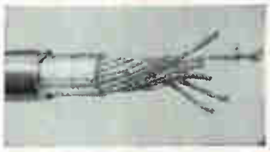
ELECTRONIC COUNTERS, INC., 155 Eileen Way, Syosset, L. I., N. Y. Design of the model 851 megacycle frequency-time Digimeter enables inexpensive conversions to control and data system applications. Two identical 1-2-4-8 BCD counting trains, combined with two identical











At Hitemp – Quality is not an illusion

The illustration above is a clever art illusion. The illusion of comparable quality that different brands of wire and cable give is also clever. To the naked eye, they seem identical.

Most brands of wire and cable may be produced with similar materials and equipment. One brand, however, will outlast, outperform the others — Hitemp.

The reason? Because Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

Hitemp is a Division of Simplex Wire & Cable Co.

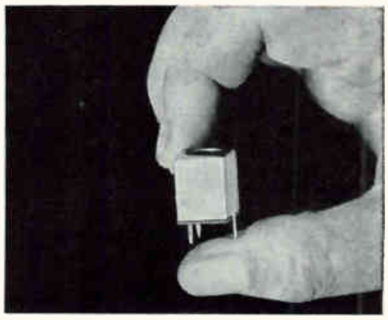
HITEMP WIRES CO.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.

CIRCLE 85 ON READER SERVICE CARD

input amplifier channels and a switching unit, comprise the basic building blocks of the counting system. Logical interconnections are effected by d-c level control.

CIRCLE 321 ON READER SERVICE CARD

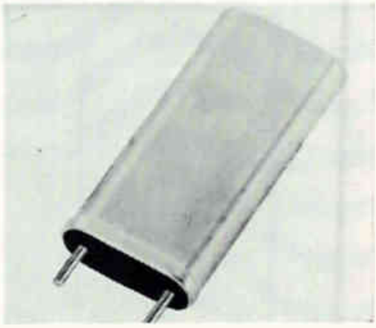


Variable Inductors

SUBMINIATURE

WELLS ELECTRONICS CO., 1701 S. Main St., South Bend, Ind. Series 387 shielded variable inductors covers an inductance range of 1.5 μh up to 3.0 millihenries. All are ½ in. by ½ in. by ⅝ in. in size and suitable for p-c board applications.

CIRCLE 322 ON READER SERVICE CARD



L-F Crystal

HIGH TURNOVER

MONITOR PRODUCTS CO., 815 Fremont Ave., South Pasadena, Calif., announces low frequency crystal MC13 (frequency range 16-500 Kc) featuring high turnover, close stability (±0.005 percent from 0 to 60 C) and high temperature operation (− 65 C to + 200 C).

CIRCLE 323 ON READER SERVICE CARD

Fan Driver

PALO ALTO ENGINEERING CO., 620 Page Mill Rd., Palo Alto, Calif. D-c powered driver unit permits operation of a-c fans over wide range of power line frequencies.

CIRCLE 324 ON READER SERVICE CARD

PRODUCT BRIEFS

WIDEBAND AMPLIFIER 1 to 100 Mc. Teltronics Inc., 23-27 Main St., Nashua, N. H. (325)

OSCILLOSCOPE 0.2 milliμsec rise time. Edgerton, Germeshausen & Grier, Inc., Boston, Mass. (326)

SILICON STRAIN GAGE microminiature unit. Micro Systems Inc., 319 Agostina Road, San Gabriel, Calif. (327)

WIRE-WOUND RESISTOR 1 $\mu\mu$f distributed capacitance. Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif. (328)

FREQUENCY METER high resolution. FXR, a division of Amphenol-Borg Electronics Corp., 25-26 50th St., Woodside 77, N. Y. (329)

MICROMINIATURE RECTIFIERS high ampere surge. Micro Semiconductor Corp., 11250 Playa Court, Culver City, Calif. (330)

H-V MINIATURE CAPACITORS encapsulated. Dearborn Electronic Laboratories, Inc., P. O. Box 3431, Orlando, Fla. (331)

PRECISION MILLIVOLT SOURCE direct reading. Monroe Electronic Laboratories, Inc., P. O. Box 3431, Orlando, Fla. (332)

TRANSISTOR MARKER prints 3,000 per hr. Markem Machine Co., Keene, N. H. (333)

FLUSH LAMP CONTROL PANEL high reliability wiring. Bodner Products Corp., 238 Huguenot St., New Rochelle 2, N. Y. (334)

SEMICONDUCTOR COOLING PACKAGE complete accessibility. Wakefield Engineering, Inc., 414 Main St., Wakefield, Mass. (335)

ROTARY SOLENOID features low input current. John Oster Mfg. Co., Racine, Wisc. (336)

P-C CARD FILE rack-mounting. Western Devices, Inc., 600 W. Florence Ave., Inglewood 1, Calif. (337)

SMALL CAPACITORS high voltage. Corson Electric Mfg. Corp., 540 39th St., Union City, N. J. (338)

SERVO MOTOR high torque output. Daystrom, Inc., Transicoil Division, Worcester, Pa. (339)

Literature of the Week

HOT GAS SERVO SYSTEMS General Electric Co., 600 Main St., Johnson City, N. Y. Bulletin LMEDJ 2817 describes a family of hot gas servos for missile, drone, and space vehicle flight control. (340)

SERVO INDICATOR Consolidated Airborne Systems, Inc., 900 Third Ave., New Hyde Park, N. Y. Design advances in servo/indicator airborne control and measurement instrumentation are detailed in specification sheet DST-461. (341)

MODULAR CABINETS Cabtron Division of Argus Mfg. Co., 1218 So. Western Ave., Chicago 8, Ill., introduces a catalog on standard modular cabinets for electronics instrumentation featuring the built-in blower cabinet. (342)

INSTRUMENTS Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, O. The 1961-62 catalog details the entire line of the company's instruments, including many new products introduced during the past year. (343)

TUNNEL DIODE POWER SOURCE Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., has available a technical bulletin covering the model TD6M tunnel diode power source. (344)

INDICATOR LIGHTS Transistor Electronics Corp., 3357 Republic Ave., St. Louis Park, Minn. Data sheet 155 details the features, specs, outline drawings and ordering information on the MTL series transistorized indicator lights. (345)

SIDEWALL HYBRIDS Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick, Mass. Twelve-page catalog describes more than 100 sidewall short-slot hybrids, covering waveguide sizes from WR15 to WR2100. (346)

H-F TRANSFER VOLTMETER Ballantine Laboratories, Inc., Boonton, N. J. A four-page folder illustrates and describes model 393 high frequency transfer voltmeter. (347)

SATELLITE-BORNE CONVERTER Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif. Bulletin contains performance specs and operating details of a new 80 w d-c to d-c converter designed to power satellite instrumentation. (348)

POWER SUPPLIES NJE Corp., 20 Boright Ave., Kenilworth, N. J. A 16-page catalog covering hundreds of models makes possible simple and exact specification of power supplies to match required parameters. (349)

SONIC ELECTRONIC CATALOG H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. Short form catalog features a complete line of sound measuring and analyzing instruments, industrial amplifiers, speakers and f-m tuners. (350)

MAGNETIC DETECTOR TEST SET Kearfott Division, General Precision, Inc., Little Falls, N.J. Advance technical data sheet describes a portable, self-powered unit for rapid, economical flux gate field testing. (351)

CATHODE RAY TUBES Continental Electronics Corp. of Calif., 2724 Leonis Blvd., Los Angeles 58, Calif., offers a revised condensed catalog of its industrial cathode ray tubes. It is arranged in easy-to-read reference chart style. (352)

POWER SUPPLY BROCHURE Electronic Measurements Co., Inc., Eatontown, N.J. Eleven models in a series of constant-current d-c power suplies are described in specification sheet 3072B. (353)

TERMINAL BLOCK CONNECTORS AMP Inc., Eisenhower Blvd., Harrisburg, Pa. A 4-page folder details specifications on the Termi-Blok, a modular terminal panel wiring block. (354)

VOLTAGE-CURRENT CALIBRATOR Rese Engineering, Inc., A and Courtland St., Philadelphia 20, Pa. Bulletin 60-C describes model 1082 precision voltage-current calibrator that features high measurement sensitivity. (355)

PULSE TRANSFORMERS Polyphase Instrument Co., Bridgeport, Pa. Booklet contains charts, tables, formulas, and instructions for selecting the pulse transformer for a particular circuit. (356)

MICROWAVE TEST INSTRUMENTS Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N.Y. Catalog digest lists applications and specifications of a line of microwave test instruments. (357)

Alto Scientific Opens Another Plant

THE SIX-YEAR GROWTH of a small Palo Alto electronic components manufacturer into a sub-contract facility producing quality electronic equipment is highlighted by the recent opening of Alto Scientific Co., Inc.'s new 12,000-sq-ft plant.

Founded early in 1955 by David Cherry and two associates, with the objective of pioneering in developing solid-state commercial electronic equipment, Alto started in a 1,000-sq-ft garage employing 4 people. Progressively, an engineering staff was formed to maintain contact with the state-of-the-art component and design theory.

In August, 1955, the company moved to a 4,800-sq-ft plant to serve Stanford Research Institute, Varian, Stanford University, Sylvania, General Electric and other local manufacturers. In 1958 Alto expanded the plant to 8,000 sq ft and branched into the military field with missile ground and airborne components. This led to Alto's design and development of checkout systems and, to the growth of an organization of specialists in the military sub-contract field.

Now with the opening of the additional plant to supplement existing facilities, Alto will continue to expand its research and development activities in applying advanced techniques and components. The new plant also has facilities for mechanical design, sheet metal fabrication, spray painting, welding and riveting, transformer winding and other production.

Alto anticipates 1961 sales of $1 million.

Farnsworth Joins LFE As Senior Staff Engineer

EDWARD P. FARNSWORTH has joined the advanced sciences division of Laboratory For Electronics, Inc., Boston, Mass., as senior staff engineer. He will be responsible for investigation and development of new technical areas and products for LFE Electronics, specializing in advanced research in communications and radar.

As a project engineer at Raytheon's missile and space division before coming to LFE, Farnsworth was most recently in charge of high speed digital data conversion and recording systems for multi-beam radars.

Monitor Systems Names Fernandez-Rivas

LUIS A. FERNANDEZ-RIVAS has been named chief engineer and technical director of Monitor Systems, Inc., Fort Washington, Pa., designer and manufacturer of advanced high-speed electronic data systems for defense and industry.

Prior to joining Monitor Systems Inc., a subsidiary of Epsco, Inc., Cambridge, Mass., he was engineering manager of the advanced programs department at Epsco, where he was responsible for programs involving developmental effort.

Kepco Hires Moerman As Chief Engineer

KEPCO, INC., Flushing, N. Y., manufacturer of voltage regulated power supplies, announces the appointment of Nathan A. Moerman as chief engineer for electronic equipment.

Moerman has served as president of Electronic Counters, Inc. For over ten years he was chief engineer and 2nd vice president of Potter Instruments Corp. During the war years he served as the civilian head of the Instrumentation Laboratory at the Aberdeen Proving Grounds.

Announce Formation Of New Company

DALLAS, Texas, will be home base for a newly formed electronics firm to be known as Hunt Electronics Co.

Management personnel will include: R. K. Davis, marketing manager; F. B. Hoff, device development manager; J. L. Hutson, materials development manager; J. W. English, product engineering manager; and E. N. Kile, manufacturing manager.

Sample production is slated to begin in October when the com-

HOLD IT!

THERE'S NO SUBSTITUTE FOR AN ELECTRONIC MEASUREMENTS CONSTANT-CURRENT POWER SUPPLY

what every engineer knows about constant-current power supplies . . .

How do you check the peak inverse voltage rating of a solid state junction? the breakdown voltage of a reference diode at a specified current? the dynamic impedance of a reference diode? and the many other parameters that are so easily checked with constant-current power supplies?

It's an easy matter to convert some voltage-regulated power supplies to current-regulated operation. At least it's easy with an E/M® Regatron Programmable Power Supply. But for true constant-current performance, there's no substitute for a power supply specifically designed for constant-current operation.

Take Electronic Measurements' Model C638A shown here. It's an easy matter to set the current control to any value desired—from a few microamperes up to 100 ma—manually or programmably. And there's no juggling with makeshift, extra circuity. Then you can adjust the voltage compliance to any value from 0 to 1500 V. There's no fear that the voltage may be too great or not enough; the voltage control sets the upper limit.

Here are some additional features of the C638A: Output impedance is 10^4 megohms at 0.5 μa to 0.5 megohms at 100 ma. Above 2.2 μa, regulation is better than 0.15%, line or load, Ripple is less than 0.01%+ 1 μa rms. A modulation input is provided.

But to get back to the point; to check the peak inverse voltage rating of a solid state junction, simply set the output current control of an E/M Constant-Current Power Supply at the specified current. Connect the output to the junction, turn the power supply on, and measure the voltage drop across the junction. What could be easier? And other measurements can be made almost as easily.

For a complete discussion of constant-current power supplies with ratings up to 1A, ask for Specification Sheet 3072B. It lists all the models and specifications, too.

®Registered U. S. Patent Office. Patents Issued and Pending.

E/M

ELECTRONIC MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN • NEW JERSEY

pany will become actively engaged in the manufacturing of semiconductor devices.

General Instrument Elects Friedman

ELECTION of Maurice Friedman as a vice president of General Instrument Corp. is announced. Formerly executive vice president of the company's semiconductor division, he will also serve in the newly created post of executive assistant to the president, and will be responsible, under president Moses Shapiro, for "coordinating activities of General Instrument's 18 divisions and subsidiaries and for development of the company's long-range acquisition program."

ACF Electronics Appoints Kirby

FRANK N. KIRBY has been named engineering manager for the Riverdale, Md., plant of the ACF Electronics Division of ACF Industries, Inc.

Kirby joined ACF Electronics from the Missile and Space Division of the Raytheon Co., Bedford, Mass., where he was a technical director. Prior to joining Raytheon, he was associated with the Canadian Marconi Co., Montreal, and the Electronics Division of

American Machine & Foundry Co. at Boston.

Auerbach Electronics Names Sunshine

BERNARD SUNSHINE has been appointed to the technical staff of Auerbach Electronics Corp., Philadelphia, Pa. He has been concerned with special error situations in connection with the input-output programming of the ComLogNet project, a large-scale digital communication system.

Previously, Sunshine was a member of the communications group of the Philco Corp.

PEOPLE IN BRIEF

Harry L. Benjamin advances at United Aircraft Products to vice president for marketing and engineering. *George M. Leitch*, formerly with North American Aviation, joins Ford Motor Co.'s Aeronutronic division as special assistant for electronic operations. *Michael Burlingham* and *Michael N. Lompart* of Burton Manufacturing Co. move up to vice president, general manager and vice president, treasurer, respectively. *Max P. Forrer* leaves General Electric to become a senior engineer at Kane Engineering Labs. *William D. Hogan* promoted at Sylvania Electric Products to manager of engineering services for the semiconductor division. *Robert L. Rugh* transfers from Acoustica to Standard Rectifier Corp. as quality control manager. *Lawrence Sokoloff*, previously with Sylvania Electric Products, appointed a senior technical staff member by Auerbach Electronics Corp. *J. Penn Rutherfoord*, executive vice president of International Resistance Co., elected to the firm's board of directors. *John B. Chatterton* leaves Moller Instrument Co. to join PRD Electronics as senior project engineer for the research division. *Ralph M. Tidball* of IBM's general products division advances to senior engineer. *Hugh Christian* transfers from Diamond Power Specialty Corp. to Ling-Temco Electronics' Electron Corp., as administrative engineering assistant.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

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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.

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

COMPANY	SEE PAGE	KEY #
THE BOEING COMPANY Seattle, Washington	92	1
CENTRAL RESISTOR CORP. Addison, Illinois	95	2
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pennsylvania	95	3
ESQUIRE PERSONNEL Chicago, Illinois	95	4
GENERAL DYNAMICS/ASTRONAUTICS San Diego, California	96	5
GYRODYNE CO. OF AMERICA INC. St. James, L. I., New York	95	6
I B M CORPORATION Lexington, Kentucky	100*	7
LABORATORY FOR ELECTRONICS Boston, Massachusetts	30	8
REPUBLIC AVIATION Farmingdale, L. I., New York	99*	9
TROPICAL RADIO TELEGRAPH CO. Hingham, Massachusetts	95	10
Suite 1414 (E)	100*	11

*These advertisements appeared in the 8/18/61 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) 8251

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

TRANSFORMER ENGINEER

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

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

Erie Electronics Division

Erie Resistor Corporation

645 West 12th Street Erie, Pa.
GL 6-8592

RESISTOR ENGINEER

Progressive manufacturer of Metal Film Resistors located near Chicago needs an experienced engineer to take charge of their precision resistor line. Must be experienced on Mil type resistors. Excellent opportunity for the right person to manage this division.

CENTRAL RESISTOR CORP.

507 Factory Road Addison, Illinois
National 5-9332

SECTION HEAD . . . SYSTEMS ANALYSIS

Salary $16,000+

Broad experience in missile engineering required. Be familiar with missile hardware and be able to determine total systems specifications and customer needs. Vacationland area. Client assumes all employment expense.

ESQUIRE PERSONNEL
202 S. State St., Chicago 4, Ill.

COMMUNICATIONS ENGINEER

College graduate interested in associating with long established public service company serving Central America. Position open at Engineering Dept., Tropical Radio Telegraph Company, P. O. Drawer 97, Hingham, Massachusetts (Near Boston).

EFFECTIVE ENGINEER RECRUITMENT DEPENDS ON ENGINEERING READERSHIP

Where your recruitment program calls for qualified engineers in the electronics industry, there is no more efficient method of reaching them than through the pages of the publication they pay to read.

electronics

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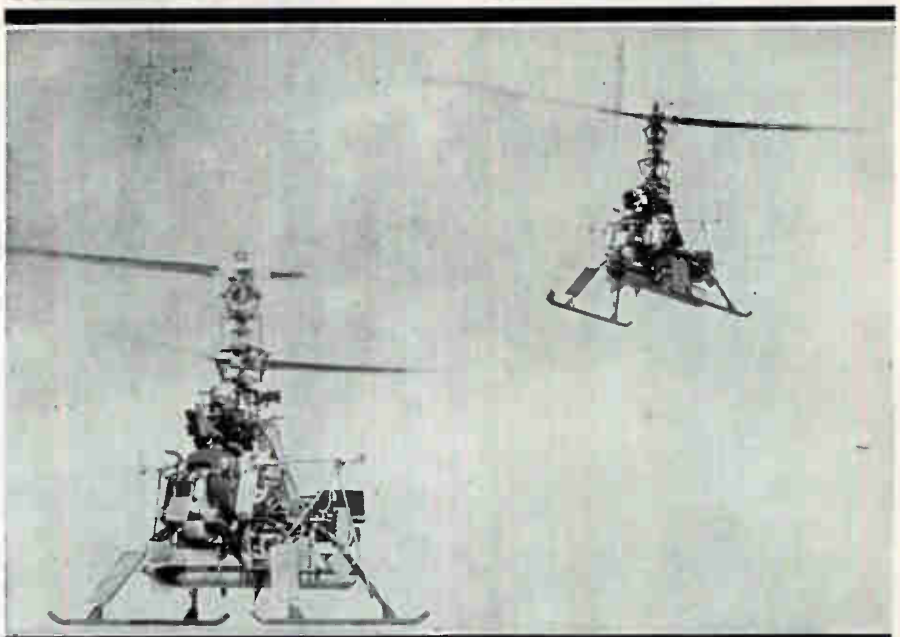


WHERE IS THE PILOT?

He has been replaced by a flight controller located at the drone control station of a navy destroyer. He is flying the Gyrodyne DSN Helicopter, armed with a homing torpedo, by remote control. The controller has the capability to direct the DSN over the target area, release the weapon, and command it to return and land on the flight deck of the destroyer.

The Gyrodyne DSN helicopter, being unmanned, can fly in foul weather and complete its mission without risk to a pilot's life.

The DSN helicopter is the first remotely controlled helicopter and is considered to be the most versatile remotely controlled flying machine.

The Gyrodyne Company is responsible for development and production of the DSN helicopter including its electronic equipment, and the electronic equipment required aboard the destroyer to control the DSN helicopter.

The work involved in accomplishing such a task is continually creating career opportunities for qualified personnel at various levels in the following fields.

The DSN helicopter is the advanced engineering version of the piloted ROTORCYCLE shown below the vehicle which on June 1, 1961 won the Grand Prix for its maneuverability in the helicopter competition at the International Air Show.

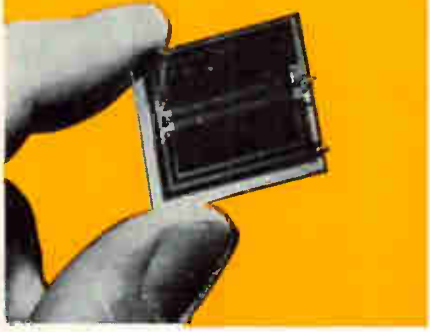
Engineering
- Flight Test
- Aerodynamics
- Stress Analysis
- Digital Data Link
- Electrical Systems
- Electronic Systems
- Contracts
- Field Service
- Publications
- Training

Administration
- Contracts (LLB)
- Facilities
- Systems—Procedures
- Systems—Audit
- Facilities Planning
- Data Processing
- Personnel Recruiting
- Production Planning
- Material Controls

Applicants interested in becoming associated with a progressive organization located in one of the most beautiful suburban residential areas on Long Island, are requested to submit confidential resumes to our Personnel Director, Dept. E, Gyrodyne Company of America, Inc., St. James, L.I., N. Y.

Gyrodyne
COMPANY OF AMERICA, INC.
AN EQUAL OPPORTUNITY EMPLOYER

COMPANY-SPONSORED RESEARCH:
THIN FILMS AND SOLID STATE



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A large company-sponsored program in thin film and solid state research for applications to *Microminiaturization, Solar Energy Conversion,* and *Magnetic Computer Components* is in progress. Included are: (1) studies of the kinetics and structures of films using advanced electron microscope techniques; (2) epitaxy studies using pyrolytic vapor decomposition and ultra-high vacuum deposition of thin film crystals; (3) materials research for thin film passive and active components prepared by vacuum deposition, sputtering, anodization and electron beam graphics and cathodolysis; and (4) techniques for accurately monitoring and controlling the fabrication conditions and film characteristics for thin film microcircuit and large area energy conversion device fabrication.

If you are interested and have experience in these tasks and are trained in solid state physics, metallurgy and ceramics, physical chemistry or electronics, inquire now. Advanced degrees preferred but not necessary if talent and experience in these areas are indicated.

Please write Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Dept. 130-90.

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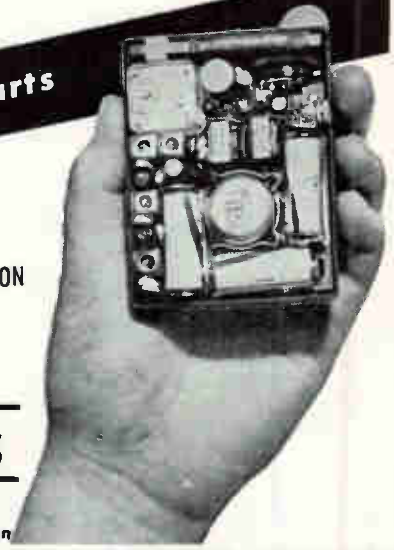

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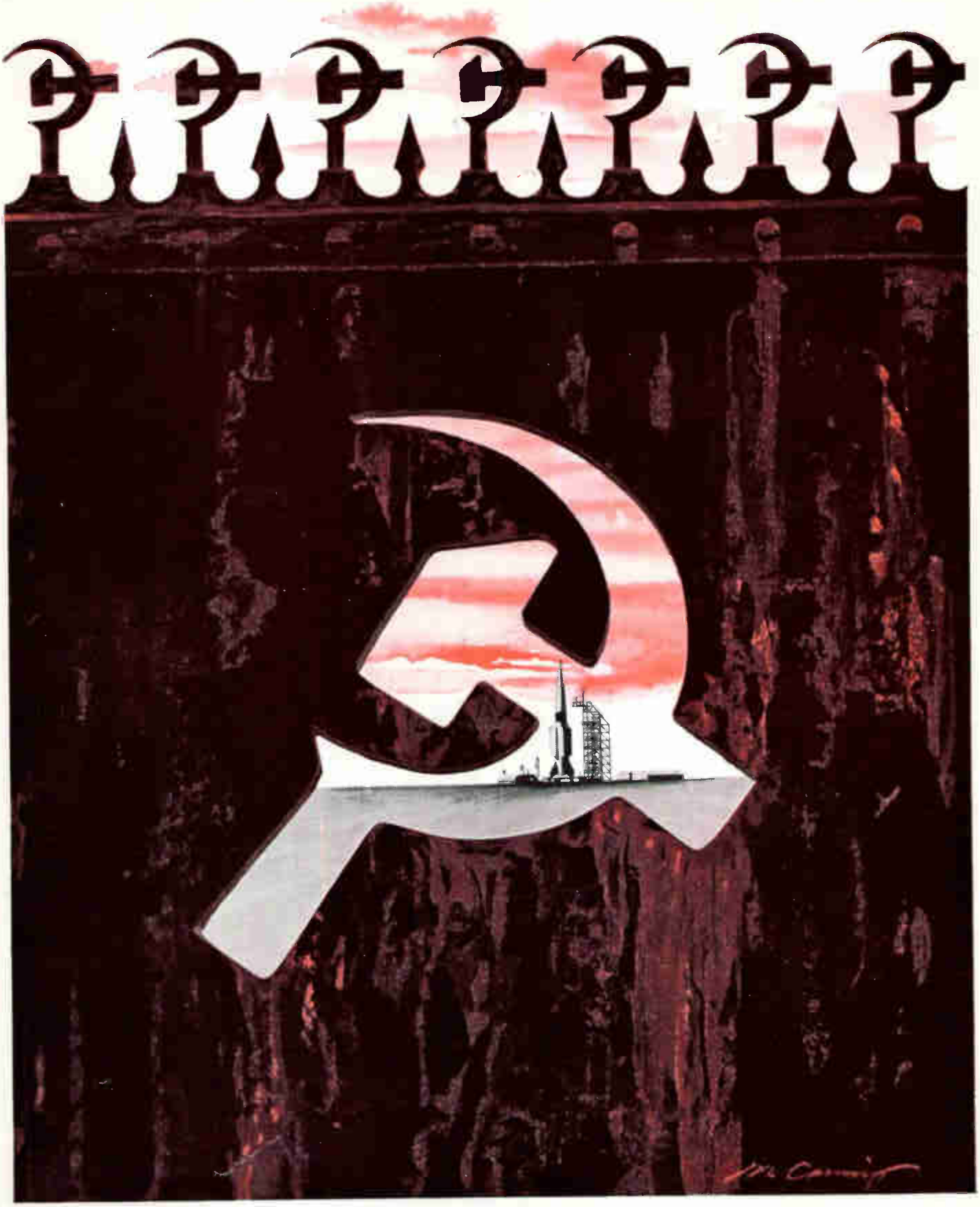

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