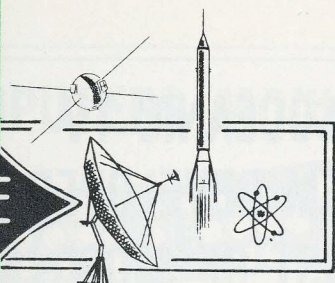


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## DIGEST

CURRENT DEVELOPMENTS IN  
ELECTRICAL ENGINEERING AND SCIENCE

Published by AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS for students



■ **London, England** . . . A new type of optical maser has been developed by U. S. scientists, as reported in the British journal *Nature*. This maser uses a silver-coated crystal, such as potassium chloride, with tiny openings to let light rays pass through. The light would be amplified due to the many reflections within the crystal, as in the ruby maser.

■ **Cambridge, Mass.** . . . A new, paper-thin ceramic filter in a container the size of a pea is designed to replace standard parts in both transistor and vacuum-tube radio receivers. U. S. Sonics, Inc., is manufacturing the filters at a rate of 30,000 daily.

■ **San Francisco, Calif.** . . . A satellite whirling through outer space can land at a space station with the help of magnets. Creating electromagnetic fields around its hull could eliminate some of the complex systems now proposed, the American Astronautical Society was told here.

■ **Washington, D. C.** . . . The National Bureau of Standards has issued two more standard samples of radionuclides, bringing the total number now available to 51. One, iron-55, is a positively charged emitter of X-rays and Auger-electrons, having a half-life of 2.7 years. The second, promethium-147, emits pure beta rays and has a half-life of 2.5 years.

■ **San Diego, Calif.** . . . "Death rays" will be among the new weapons revolutionizing anti-missile warfare during the next 50 years, a joint meeting of the Institute of Aerospace Sciences and U. S. Navy National Aviation was told recently. It is already possible in theory to focus short wave radiation from lasers in quantities large enough to burn through steel plates ten miles away in space.

■ **Washington, D. C.** . . . A string of automatic buoys along the U. S. Atlantic coast is now measuring the ocean currents. Woods Hole Oceanographic Institution scientists have planted 14 buoys strung out along a 670-mile line stretching from New England to Bermuda. Bobbing on the open ocean in waters up to three miles deep, the floats are continuously and automatically recording oceanographic data.

NEW ION ENGINE HELD KEY TO  
U. S. INTERPLANETARY EXPLORATION

**POWER TO THE PLANETS** — An ion engine, demonstrated for the first time recently, is shown above. This type of propulsion, which could be the key to very long range space travel, generates less than a tenth of a pound of thrust by accelerating ionized cesium atoms.

An experimental ion engine — the principle of which has been described by many scientists as the "ultimate" in propulsion devices for space travel — was shown in actual operation recently to newsmen. The engine can maintain a speed of two million miles a day for a manned space craft during its space flight to Mars.

Scientists said a more advanced version of the engine will be ready for flight test next year. Present plans call for an initial space test in late 1962. A complete ion propulsion system including a nuclear-electric power supply may be tested as early as 1965.

Private industry and the Government have been concerned with electric propulsion for several years and much work is now being done throughout the country.

## TEST LAUNCHING

The 1962 flight test, the first of a

series, will see a capsule launched by a Scout rocket carrying two ion engines. The capsule will be launched almost vertically to an altitude of about 5,000 miles. This will provide a space flight of about one hour duration in which to demonstrate the functioning of ion engines under actual space conditions.

Hughes Aircraft Company, which is developing the ion engine under contract from the National Aeronautics and Space Administration, conducted the demonstration at its research laboratories in Malibu, Cal.

## MAY FRINGE SOLAR SYSTEM

Dr. Ernst Stuhlinger, director of the NASA Marshall Research Projects Division and a world authority on electric propulsion, has predicted that the ion propulsion system will come into its own on missions to the planets and as far out as the fringes of the solar system.

He said: "Based on realistic forecasts of our technical capabilities in the near future, conceptual design studies of manned space vehicles indicate that an electrically propelled spacecraft to Mars and back to Earth could be built with a useful payload of the order of 50 per cent of its total initial mass, and with a travel time which is about equal to that of a spacecraft with a chemical or a nuclear power plant.

"A reasonable estimate for the time of this project may be 1975 or 1980," he said. "Unmanned, instru-

(Continued on page 6, column 3)

AIEE MOVES TO NEW BUILDING;  
UEC HOUSES 19 SOCIETIES

The American Institute of Electrical Engineers moved into its new quarters — the \$12,000,000, 20-story United Engineering Center building in New York — in early September.

In addition to AIEE, the new Center houses the four other "Founder Societies" of United Engineering Trustees, Inc., in addition to fourteen other major engineering groups. This new building at 47th and 48th Streets on New York's United Nations Plaza, thus encompasses the greatest assembly of professional engineering organizations and information in the free world.

## Three Floors

AIEE occupies part of the ninth, the tenth, and the eleventh floors of the new building (as indicated by the white lines on the adjacent photo).

The new United Engineering Center, in addition to providing headquarters space for the engineering societies, also has an auditorium, several meeting and conference rooms of varying capacities, an exhibit area, a library and a cafeteria. The building represents the latest developments in engineering and building techniques.

The slim 283-foot-high tower of



glass, stainless steel and limestone rises from a broad two-story base of glass and stone. With 260,000 square feet of space, the Center provides 18 stories of office space and two of mechanical equipment.

The impressive lobby is walled in marble with floors of terrazzo. On the east side of the lobby is the display area of 6,235 feet with ceiling-high windows overlooking United Nations Plaza.

If you are in the area be sure to drop in for a friendly visit.

Million Kilowatt  
Generator Planned  
For New York City

A steam turbine generator with a capacity in excess of 1,000,000 kilowatts, largest single generator ever ordered by any utility, will supply electric power for New York City.

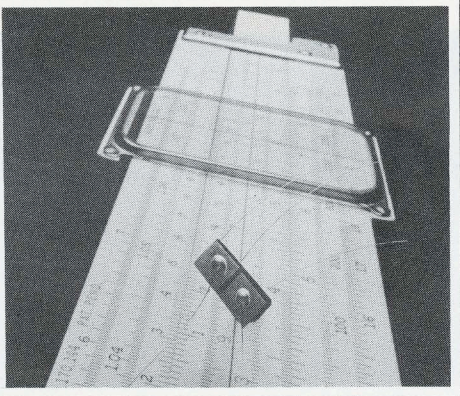
The giant generator, ordered by Consolidated Edison Company from the Allis-Chalmers Manufacturing Company, is scheduled to come on line early in 1966. The generator will be able to supply the residential power needs for about 3,000,000 persons.

The development has been hailed by the electric power industry as a major advance in the utility field.

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## TINY 'MOLECULAR SLIDE RULE'



Scientists have demonstrated a unique electronic device which might best be described as a "molecular slide rule." The tiny device electronically performs multiplication and division by a process similar to that used in the familiar mechanical slide rule so widely used for mathematical calculations.

Yet the new multiplier-divider has no conventional electronic components or circuitry.

### Slice of Silicon

It is simply a solid slice of silicon about the size of the head of a thumbtack and as thick as a few sheets of paper, with logarithmic instead of linear characteristics.

The molecular slide rule is the latest subsystem, or functional electronic block, to be demonstrated by Westinghouse laboratory scientists through the principle of molecular electronics.

Molecular electronics, a promising new approach to electronic systems, does away with traditional circuits built from arrays of electronic components such as tubes, transistors, resistors, and the like.

### Rearranging Structure

Instead, the same function is performed by rearranging the internal structure of a solid semiconductor crystal. Electronic behavior occurring within or between regions in the crystal gives the same effect as an entire electronic circuit (subsystem), or even a whole system.

The multiplying and dividing function performed by the new functional block is equivalent to that done by an array of four separate diodes, or three diodes and a transistor. The functional block, however, is capable of greater accuracy than the assembly of individual components.

## TRANSOCEANIC TV SYSTEM DEVELOPED AT COST OF \$1000

A television transmission system reportedly developed at a cost of about \$1,000 was demonstrated recently by an inventor who claims it can be adapted to low-priced transoceanic telecasts.

The system, built by Dr. Sid Deutsch, Associate Professor of Electrical Engineering at Polytechnic Institute of Brooklyn, employs shortwave broadcasting, rather than microwave relay stations such as those proposed for communications satellites.

### Narrow Band

Instead of the signals requiring a bandwidth of 4,000,000 cycles per second as in conventional television, the Deutsch equipment uses a band only 45,000 cycles per second wide. A spot of light moves horizontally across the picture tube at 20 cycles per second and vertically at 2,250 cycles per second, compared with 15,750 cycles hori-

zontally and 60 cycles vertically in conventional television.

The coarse movements are received clearly because of a "pseudorandom" scanning device, so-called because of its "hop, skip and jump" kind of motion. The scan and a yellow-colored screen eliminate flickering. A transoceanic telecast by shortwave would be rebroadcast on home screens in black and white.

Dr. Deutsch said the picture quality is "somewhat inferior" to standard television, but equivalent to shortwave signals originating in Europe and rebroadcast locally. The slow scan makes 1.6 seconds necessary for a complete fadeout, leaving a ghost-like image visible after a quick motion.

### Classroom Use

The system was developed primarily to record classroom lectures inexpensively with a stationary camera. Lectures and laboratory demonstrations can be recorded on a standard dual-channel tape recorder with the tape running at 30 inches per second, rather than the usual 15.

Dr. Deutsch said he spent \$800 for a standard closed-circuit system and about \$200 to convert it for shortwave transmitting.

## BALLOONS USED TO STRING CABLE ACROSS JAPAN STRAITS

Balloons rented at \$2.78 a day have been used to string cable across dangerously turbulent straits.

The unique airlift was used by utility engineers to lift a first 9-mm (about 3/8 in.) pulling line across a mile wide stretch of the Naruto Straits to power-link Skikoku with Awaji Island in the Seto Inland Sea in Japan, according to Electrical World.

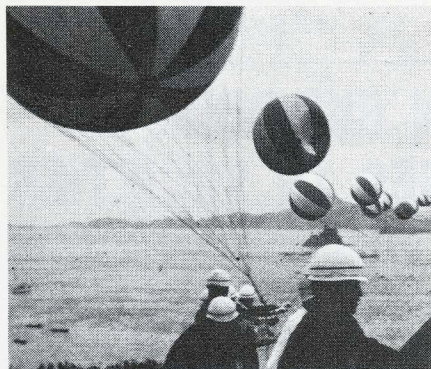
The balloons were able to string the cable in about two hours. More important, they did the job where more conventional methods such as boat stringing routines, helicopters, or a submarine cable would have failed.

### Sea Currents

Because of the need to keep the channel open to shipping, only short interruptions to traffic were permissible. This eliminated conventional river crossing routines. Dangerous sea currents precluded laying submarine cable. Helicopters, a favorite device of trouble-shooters, were considered inadvisable because of the topography of the Naruto Straits.

The balloons, rented for the occasion from a firm in Osaka, inflated to 8.9-ft. diameter. They had a lifting capacity of about 16.5 lbs. per balloon. About 80 were used to fly the 5900 ft. (1050 lb.) of wire some 65 to 120 ft. above ocean vessels proceeding through the straits.

When the current was at its lowest, a tug moved out with one end of the pulling line while construction workers on shore attached inflated balloons at 65-foot intervals. As the tug progressed out toward mid-channel, it took with it



CONSTRUCTION WORKERS attach inflated balloons every 65 feet, to boat-hauled pulling line.

the end of the 9-mm wire, with the trailing length of wire floating above the water.

As it neared the shore, it was met by a second tug carrying the end of the second 12-mm pulling cable. Near the shore, away from the turbulent waters of the straits, the two cables were spliced and released. Then, the 80 balloons slowly lifted the cables above the straits.

### Retrieved Balloons

As the pulling line lifted up, the 9-mm section of the wire was gradually pulled back toward the Awaji side, and the balloons were retrieved as the wire was brought in.

It will be a routine job with conventional tension pulling equipment to progressively increase the single 12-mm messenger cable until 35.5-mm, 170-kv power line cables are suspended between the two towers.

The \$1.4 million project, built by Kansai Electric and Skikoku Power Companies, will transmit 30 Mw at 170-kv to Awaji Island.

## Silver-Zinc Battery May Play Key Role In Space Travel

It is reported that the development of a sealed silver-zinc secondary battery which may play a key part in vehicular space travel and aid in initial missile landings on other planets, will be completed this November.

The importance of the battery to space probing efforts is indicated by the fact that it could deliver a performance per unit weight eight to ten times that of the nickel-cadmium batteries now available.

The battery is being developed by Delco-Remy, a division of General Motors Corp., under a research-development contract with the U. S. Air Force.

### Basic Problems

One of the basic problems in the battery development is harmonious action of the eighteen cells so each will charge with the same intensity and discharge, as power is needed, at the same rate.

Inactivity of any one cell could cause excessive gassing and explosion, resulting in loss of power, and could possibly deflect the missile from its course.

### Nylon Casings

The cell casings are made of nylon, and each cell will be hermetically sealed into place to provide proper functioning in a vacuum.

Another problem involved is separating positive and negative plates properly, as the plate materials have a tendency to penetrate cell separators and cause short circuits.

The project's objective is to develop a battery which will deliver 13 watt hours per pound with a life of 500 two-hour cycles. A cycle is a 35-minute discharge period and an 85-minute charge period.

## NEW OSCILLOSCOPE TUBE DEVELOPED

A 3 1/4 inch cathode ray tube with a fiber optic flat face plate for oscilloscope photography has been developed.

The fiber optic face plate gives the unit light transmission efficiency of at least 30 per cent and can raise it to 80 per cent. Efficiency using conventional oscilloscope recording systems (lenses) is about 8 per cent.

Because it is flat, the fiber optic plate eliminates the need for lens systems to flatten and focus images appearing on the curved face of the tube. Contact prints can be taken directly from the flat plate.

The tube was developed by Chicago Aerial Industries, Inc.

## E E DIGEST

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Warren H. Chase—President  
N. S. Hibshman—Executive Secretary  
C. J. Grimm—Consulting Editor  
R. C. Mayer—Managing Editor

### CONSULTANTS

Roy Krezdorn E. T. B. Gross  
H. E. Corey L. F. Hickernell  
R. T. Weil

Lawrence Leonard—Student  
Co-ordinator

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# FEATS OF COMPUTERS MOUNT

The accomplishments of electronic computers continue to make headlines in many scientific areas.

For example, scientists have recently used a computer to determine the value of "pi" to 100,000 digits. The computation was done by two methods as a check on how accurately a computer can compute. Both methods gave the same answers. The computer twice determined that the last ten of the 100,000 digits for pi are: 5493624646.

It took the computer eight hours to make the calculations. In comparison, it would take a man, working eight hours a day without error on a desk calculator, 30,000 years to make the same computation.

The computation was made on an International Business Machines 7090 computer, under the direction of Drs. John W. Wrench Jr., and Daniel Shanks of the U. S. Navy's David Taylor Model Basin, at the IBM Datacenter in New York.

## Person to Person

Engineers are now able to address a computer like a person. The same words that one engineer would use to describe the solution of a problem to another engineer, can now be used to give instructions to machines, which can understand such words as inverse, adjust, intersect, ramp, area and alignment.

Prof. C. L. Miller of the Massachusetts Institute of Technology described the system, which is called COGO, for co-ordinate geometry. It is expected to increase civil engineers' use of computers.

The primitive or pseudo languages previously used to instruct machines made their use time-consuming and costly for problems that are rarely exactly alike. With COGO, it is technically and economically feasible to write a separate program for each set of data, use the program once and discard it.

## 'Fastest Ever Built'

A digital computer described as "the fastest ever built" is now in use in Lexington, Mass., at Lincoln Laboratory, a research center operated under Air Force contract by the Massachusetts Institute of Technology.

Called the FX-1, the computer is modest in size but notable for high operating speed. Lincoln technicians believe it may be the forerunner of "a new generation of machines, ten times faster than any computers in general use today."

The FX-1's "read-write cycle time" — the time needed to read a computer word out of the main memory and write in a new one — is three-tenths of a microsecond. The fastest older models took two to 12 microseconds.

The "clock rate," or timing pulse rate of the FX-1's logic circuits, is 50,000,000 pulses per second, four times the rate of the fastest commercial machine previously reported.

The working model was designed to test both fast logic circuitry and magnetic film storage. The computer is the first with a main memory using thin magnetic films

instead of ferrite cores for high-speed, random-access storage.

## Learning Machine

A new kind of machine, similar to but unlike computers, has been designed to tackle baffling problems of types which have never before been solved.

Developed by the Raytheon Company, the "Cybertron" does not work from programmed step-by-step formulas (as do computers), but attacks problems for which there is no known formula. The machine learns by trial and error, relates new situations to past experience, and steadily improves its skill.

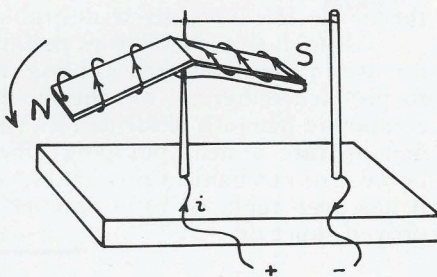
When the machine makes a mistake, a technician "punishes" it by pushing a "goof" button, forcing it to reconsider its decisions and modify its memory.

A small Cybertron, the K-100, uses punched tapes for its learning processes and its memory storage. Used in a Department of Defense project on separating true target echoes from false radar signals, it came up with the necessary information for designing an improved filter capable of extracting more reliable information from radar equipment.

## Why Does It Rotate??

Professor H. E. Stockman, Lowell Technological Institute, whose novel electrical devices have appeared in the EE DIGEST before, offers another model whose schematic sketch is presented as a puzzle.

Why does it rotate?



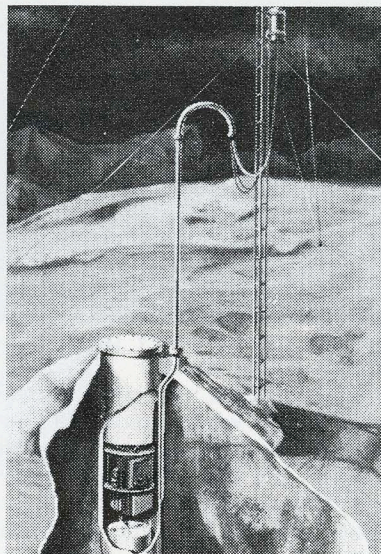
Solution to puzzle on page 6.

## A.I.E.E.'S NEW STUDENT LIAISON

Lawrence D. Leonard has been appointed student coordinator for the AIEE. He will act as a liaison between AIEE, and its student chapters, and also as consultant to the EE Digest.

Mr. Leonard holds a BA and an MA degrees from Rutgers University and NYU. He has ten years of experience in the college placement and personnel field.

He was Placement Director for NYU's Undergraduate, Evening and Graduate Engineering Colleges, which have a combined enrollment around 6,000.



RADIOISOTOPE-FUELED automatic weather station will transmit up to 1500 miles, operates 2 years without refueling.

## World's First Atom Powered Weather Station Is Built

The world's first atomic powered automatic weather station has been built recently for the Atomic Energy Commission.

Ready now to be moved into a remote location north of the Canadian mainland, it gets its power from pellets of a strontium-90 compound which generate heat spontaneously by radioactive decay.

The heat is transformed directly into a continuous five watts of electricity by a series of thermoelectric couples. The electrical energy is stored in rechargeable batteries in order to build up the power needed to operate the long-range reporting transmitters.

According to Power Engineering magazine, the station was built by The Martin Company.

## Two Masers Can Explore Inner Matter Structure

A unique "tuning fork" for exploring the inner structure of matter was reported by a British scientist recently.

Two optical masers giving off rays of different wavelengths produce a new beat, frequency wavelength equal to the difference in their wavelengths. This can be the infrared or "invisible light" rays that penetrate matter.

### Frequency Varied

The frequency of the penetrating rays is varied by heating one of the masers, Dr. D. C. Laine of the University College of North Staffordshire reported in the British journal Nature.

The other optical maser continuously gives off rays of similar wavelength. Wavelengths varied by the heated maser merge with the similar wavelength, producing distinct "beat" frequencies which can then be "tuned" within the entire range of the infrared spectrum.

### Rays Absorbed

The amount of infrared rays absorbed by substances at varying frequencies tell scientists about their structure.

This possible research tool "presents a very attractive approach to the long-standing problem of suitable sources for radiation studies in the infrared region," Dr. Laine said.

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## Electro-Technical Crossword Puzzle

Reprinted from RANDOM NOISE, a publication of Northeastern University's AIEE-IRE Joint Student Branch.

### ACROSS

1. Effect that stops motion with light
11. Single package
12. Measuring tool
13. Points (abbrev.)
14. Time for 1/e of final value
17. Was Capitol of U.S.A.
19. Follows wholesale
21. First two letters of labor union
22. Southern European country
24. Height (abbrev.)
25. Electro-Technical manual (abbrev.)
27. Type of circuit configuration
29. Connections
31. Negative
32. Armed services rating
33. Conjunction
35. Increase
37. What the 2 R's in ARRL stand for (2 words)
40. Singular occurrence
41. Ceremony
42. Instrument of communication (2 words)
46. Yarners Union
47. Full-wave rectification requires two of these
48. Alternate form of:  $I = E/Z$
50. State University in Southwest
52. Trans-Norway Airways
53. Causes resistance to high frequency flow. (2 words)

### DOWN

1. Common type of radio receiver
2. An explosive
3. Interval of time needed to reach peak value. (2 words)
4. Receive time-and-a-half for
5. Frequency generator
6. Short circuit
7. An electrode (abbrev.)
8. Open loop (abbrev.)
9. Mexican monetary unit
10. Non-permanent
14. Temporary
16. Unit of length
18. A miss is as good as a

1	2	3	4	5	6	7	8	9	10
11				12					
13			14			15	16		
			17			18			
19		20						21	
	22			23				24	
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37	38					39			
40					41				
42			43	44				45	
46			47					48	49
50	51							52	
			53						

20. Preposition
23. Famous Mass. Military Outfit
26. Metallic chemical element, #22
28. Prefix
30. Guard, isolator
31. Non-Integral (abbrev.)
34. To poke or stir once more
35. Signals which activate circuits
36. Affirmative vote
38. Direct current alternator, (abbrev.)
39. Long connection
43. Greek letter
44. Instrument to produce sound
45. Occur at same time
49. To take food
51. America
52. Twin-engine, (abbrev.)

The solution to this crossword puzzle is on page 8.



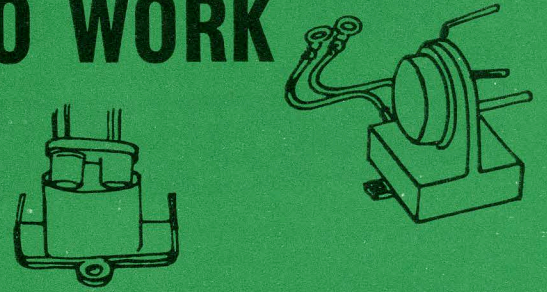
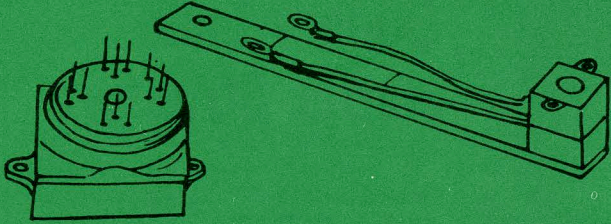
# THE THERMOCOUPLE GOES TO WORK

by

Dr. John Kelly

Westinghouse Electric Corp.

(Digested from Electronics World, July 1961)



After twenty years of dignified service in thermometry the thermocouple is suddenly appearing as a versatile electrical device.

One hundred and forty years ago Thomas Seebeck observed a flow of current through the junction of two dissimilar metals when heated. Thirteen years later (1834), Jean Peltier observed the opposite effect, that when current is passed through such a thermocouple one side of the junction is cooled and the other heated. Twenty years still later (1854), Lord Kelvin offered the first detailed theoretical explanation of the Seebeck and Peltier Effects.

Another thirty years passed before Lord Rayleigh seriously tried to use these effects to convert heat directly into electricity but little progress was made during the next fifty years. The available materials limited efficiencies to about one percent. Efficiency is relatively unimportant in instrumentation and the thermocouple came into that general use from about 1940.

## THERMOELECTRIC GENERATION

The basic concept is that the electrons can carry heat through conductive metals somewhat as do gas molecules in space. New materials developed from a knowledge of solid state physics and semiconductors have relatively recently opened the possibility of thermoelectric generators with an efficiency of the order of 10 percent and a promise of 30-35 percent after 15-20 years of development.

Figures 1 through 4 show schematically the relationship between heat and electron movement, and their use to produce electricity, or heating and cooling, with graphic reminder that heating and cooling are but two views of the same thing.

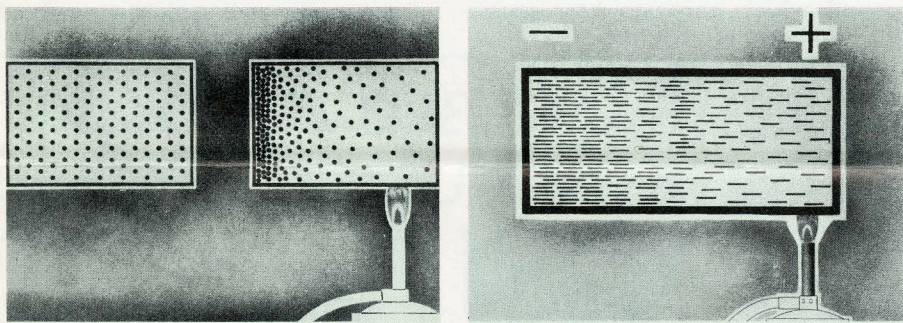


Fig. 1. Distribution of electrons in unheated and heated material.

Fig. 2. Difference in charge in the material with one end heated.

Figure 5 shows the operating efficiencies of various power sources compared to the available and future possible thermoelectric devices.

It should be pointed out, of course, that the thermoelectric generator is inherently a low-voltage, high-current, d.c. source. To be used on a larger scale, this d.c. must undergo inversion and transformation to multiphase a.c. To meet these needs, development of compatible static inverters is under way; indeed, inverter technology is ahead of generator technology at this time. Thus, the road ahead to efficient and economical power conversion seems clear.

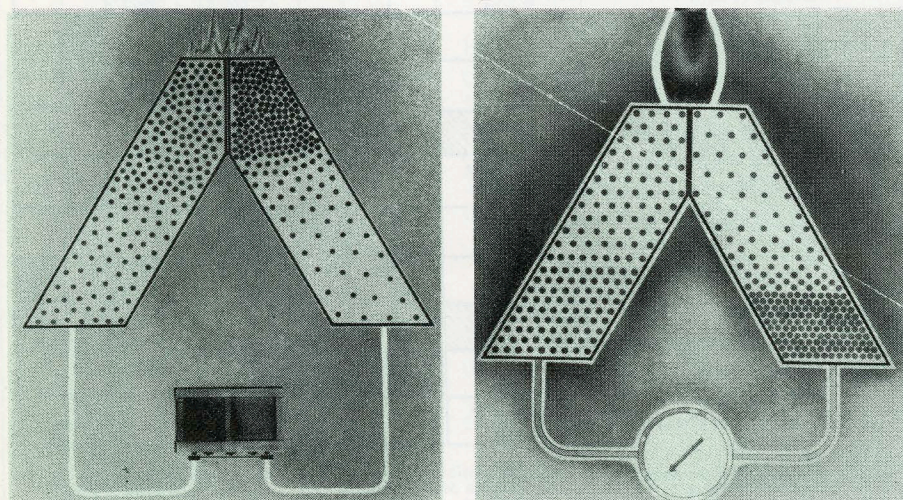


Fig. 3. When two dissimilar materials are joined together and this junction is heated, the electrons are distributed as shown. When the free ends of the two materials are connected together through an external circuit, current will flow in that circuit. This is the principle of the thermocouple, which converts heat energy into electrical energy.

Fig. 4. Demonstration of the reversible characteristics of thermoelectric materials is shown here. The application of the proper polarity of electric current (from a battery in this case) produces the movement of electrons shown. As a result of this, the junction region of the two dissimilar materials is cooled.

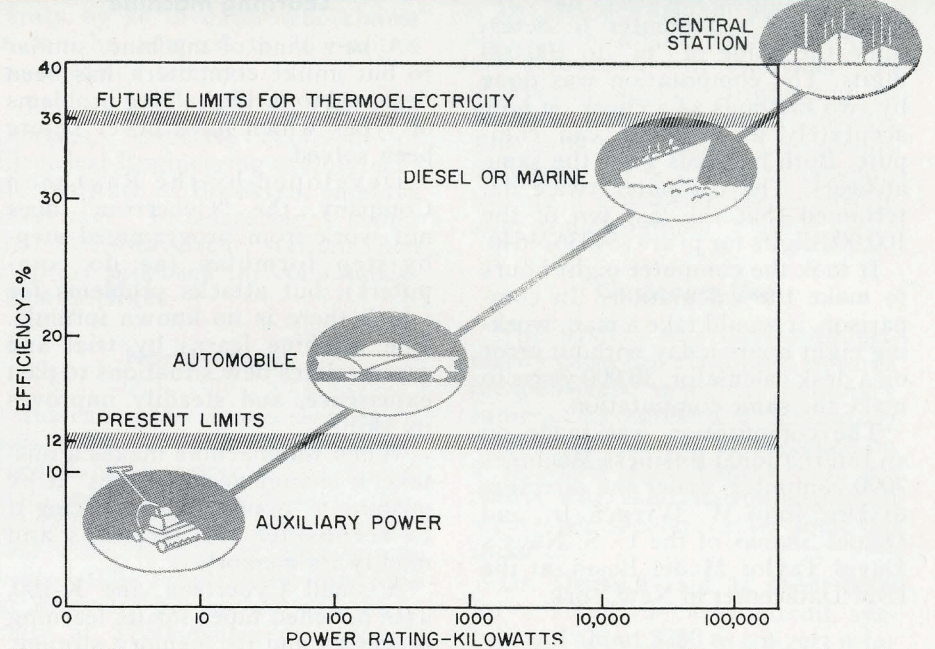


Fig. 5. Efficiency vs. power for conventional machines compared to thermoelectricity.

On the basis of capital cost, there seems little doubt that, in the absence of moving parts, thermoelectric generators ultimately can be built at a lower cost than their conventional counterparts. This fact would indicate their possible first use in many short-time or intermittent operations, such as peaking or emergency generator condition.

## SUITABLE MATERIALS

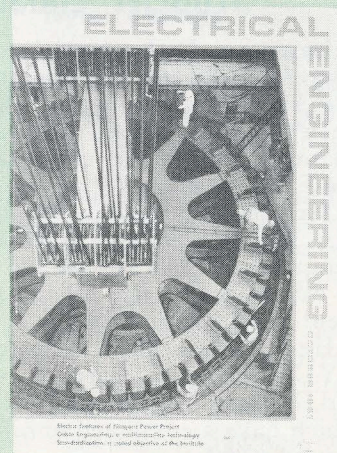
The one major problem in thermoelectricity today is the need to discover and develop suitable materials. In practice, successful thermoelectric junctions depend on a delicate balance of the properties of the materials used. This balance is among thermal conductivity, electrical resistance, and a special property called "thermoelectric power," i.e., volts-per-degree of temperature difference.

Three general classes of materials must be considered. These are metals, semiconductors, and insulators. Their physical parameters, which govern their thermoelectric properties, are shown in Fig. 6.

Metals having enough electrons to be very good electrical conductors, do not perform efficiently in thermoelectric refrigeration or power generation. Semiconductors may have an intentionally restricted number of electrons, which gives them their desired characteristics as a class of materials. They are the most efficient, although their efficiency does drop off with an increase in temperature and very high temperatures are needed for efficient power generation. Finally, insulators have so few electrons that they make very poor conductors. Yet insulators do have the highest thermoelectric voltage, a desirable characteristic for power generation.

All told, semiconductors remain the most attractive class of materials for use in thermoelectric cooling and power generation. Present research to produce materials for thermoelectric cooling is based largely on the compound bismuth telluride ( $Bi_2Te_3$ ). This formula, suitably modified, can demonstrate a heat pumping efficiency of 10 to 12 percent. However, because of mechanical properties, cost of raw materials, and other reasons, it has been replaced by a number of trade-secret substitutes which have proven superior.

## "ELECTRICAL ENGINEERING" ACQUIRES NEW LOOK

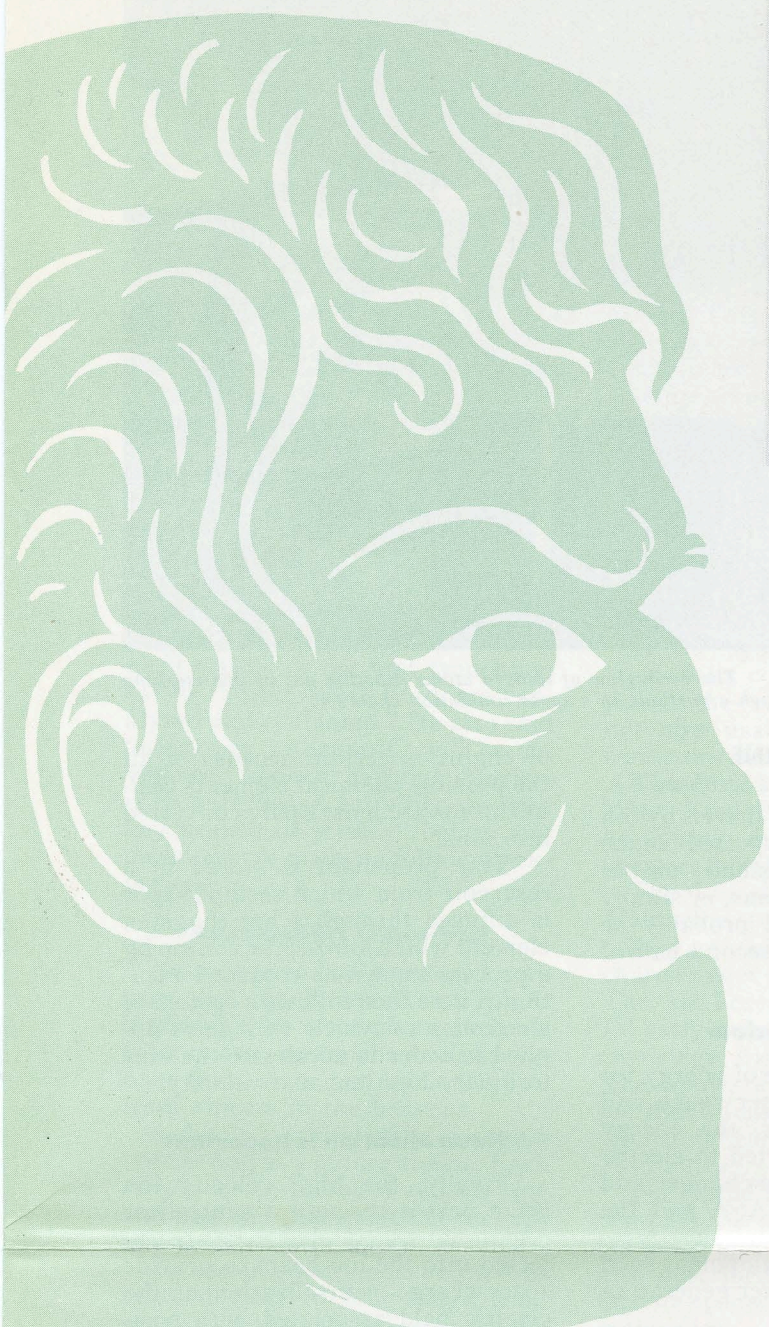


Looking ahead to serve you better "Electrical Engineering" magazine acquired a new look with an up-to-date cover, type, style, and headings. The new magazine is dressed in a streamlined format. The easy to read articles are printed in readable, modern type.

New features have been added like summaries of conference papers, Russian translated engineering works in condensed forms, and a guide to present Business Trends.

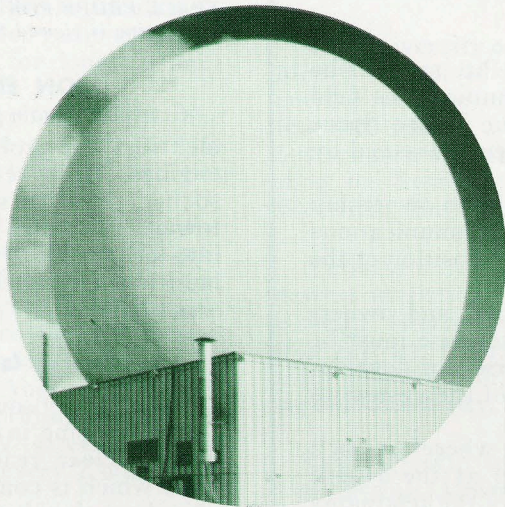
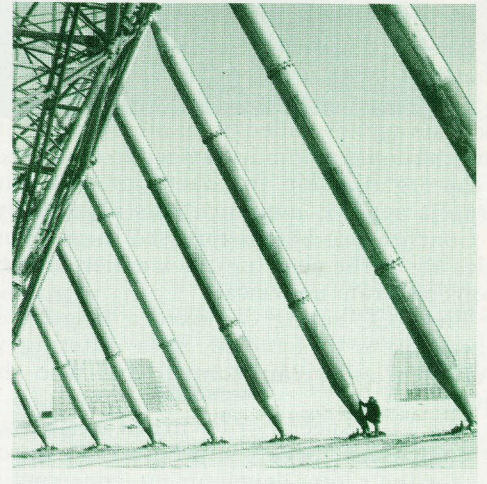
It is "THE" monthly which electrical engineering students can use to gather information.



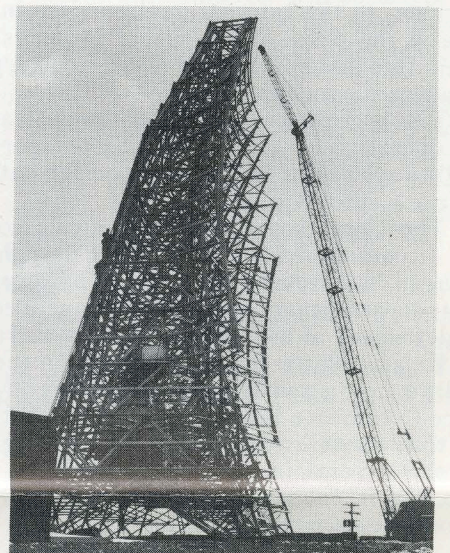


**GIANT DISH** — This tracking radar, 84 feet in diameter, is now in operation for testing purposes at RCA's Moorestown, N. J. plant. It is the prototype of tracking radars to be used in the third BMEWS site, at Yorkshire, England.

**PILLARS OF PREPAREDNESS** — Workman is dwarfed by the 60-foot long backstays for the BMEWS surveillance radar near Thule, Greenland. Each pillar-like backstay is 42 inches in diameter and weighs 7½ tons. The surveillance radar subsystems for BMEWS are being produced by General Electric.



**GIANT GOLF BALL** — This 140-foot diameter radome, which resembles a giant "golf ball," will be one of a group that will house the tracking radar antennas and pedestals at the joint USAF-RAF BMEWS Station at Yorkshire, England. The radomes and tracking radar antennas and pedestals are being fabricated by the Goodyear Aircraft Corp.



**NEW TYPES** of tropospheric scatter transmission antennas had to be designed for certain segments of the BMEWS rearward communications system. These "tropo" antennas, built by Western Electric, are larger and more powerful than any heretofore used in any tropospheric transmission system. This prototype is as tall as an 8-story building and is designed to withstand winds of 200 miles-per-hour.

### BMEWS—GIANT DEFENSE NETWORK

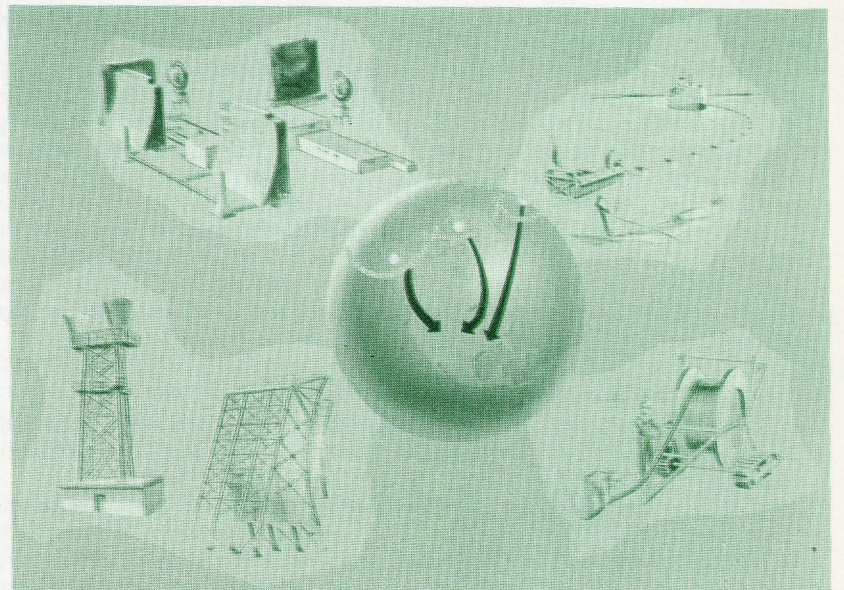
At a time when the big news in electronics has been "miniaturization," a noteworthy exception is the Air Force's Ballistic Missile Early Warning System. Here the accent is on "giantization," with a multitude of huge installations coming together to provide the free world with a giant defense communication network.

The pictures on this page give an idea of the type of operation being conducted by BMEWS. Tremendous power is generated by giant transmitters and fed through a maze of waveguide, scanner equipment, and feedhorns which bounce the radio energy off of four detection radar antennas. These antennas, each larger than a football field, project the powerful radar beams out over the polar regions toward the Soviet Union.

This curtain of energy can detect oncoming objects at a range of 3,000 miles, and will help to provide an early warning time of at least 15 minutes in the event of a sneak attack on Southern Canada and the United States.

BMEWS is the long-range ultra-high-speed radar warning system now being built under the direction of the U.S. Air Force and the British Air Ministry.

Three stations will put this giant network into effect: Our bases in Thule, Greenland and Clear, Alaska, and the British installation in Yorkshire, England. Radio Corp. of America is the main contractor for the BMEWS project.



This is an artist's representation of the BMEWS rearward communications system. The black arrows superimposed on the world map indicate the three communications links connecting BMEWS long range detection sites to the control center in the U.S. These communications links are made up of land cable lines, undersea telephone cables, radio tropospheric scatter transmission, and microwave radio relay transmission.

# GIANTIZATION





## Communications Satellites: Who Will Put Up What?



The battle over private or government ownership of communications satellites seems to be resolving. A go-ahead sign to a unified space communications program is seen in a recent FCC ruling in which the agency called upon nine United States companies engaged in international communications to make recommendations concerning the organization and operation of a joint ownership venture to operate a space communications satellite system.

Concern has been expressed in government and Congressional circles about the need for quick action in getting the space communications program underway.

The FCC ruling climaxed a lengthy discussion over how the program is to be handled, with differing viewpoints offered as to government or private control, and who should be allowed to participate.

The FCC special order urged quick action in directing that the nine companies "organize promptly" a special committee "to speed plans for their joint development, construction, ownership, and operation of a commercial satellite communication system."

### SPACE COMMITTEE HEARINGS

The proposal that private ownership of the satellite systems be restricted to the international carriers in the communications field came in the wake of a series of hearings held by the House Space Committee last spring, and a subsequent policy statement issued by President Kennedy.

The presidential policy statement called for private ownership and operation of the United States portion of a communications satellite system. It left decision on the nature and composition of the venture to the FCC.

The Commission, which controls commercial use and ownership of communications, specified that the joint enterprise must be arranged "to prevent domination by any single carrier, of development, construction, management, operation, or use of the system to the detriment of any other common carrier."

Existing differences of opinion on the hows and wherefores of a satellite communication program were pointed up at the House Space Committee hearings on the subject. The gist of the testimony was that a satellite communications program is technically feasible, but the several leading firms involved in space communications offered different views on how to go about this. A rundown on the various viewpoints follows:

### OPPOSITION TO GOVERNMENT CONTROL

Opposition to government operation and ownership of the commercial satellite communications systems was voiced by Radio Corporation of America. It could be disruptive, and not in keeping with the tradition of private industry for international communications facilities, they say.

International Telephone and Telegraph Co. has been an exponent of the private enterprise viewpoint, taking the position that a commercial satellite communications system should be the responsibility of those firms directly concerned with international telecommunications. The carriers need to control their operating systems in order to discharge their public obligations, IT&T says.

American Telephone and Telegraph Company has proposed a joint undertaking among the United States international communications common carriers and their counterparts abroad, for building and operating a microwave satellite system. Participation could be either by ownership or by leasing of facilities. This, AT&T says, need not disturb the existing pattern of regulation.

AT&T and RCA are on the joint committee to develop the commercial satellite system. Others are: American Cable and Radio, Hawaiian Telephone Co., Press Wireless Inc., South Puerto Rico Sugar Co., Tropical Radio Telegraph Co., United States-Liberia Radio Corp. and Western Union.

### PLANS FOR THIS YEAR

Three communications satellite projects, one privately financed, the others carried out using government funds, are due to place satellites in orbit within a year.

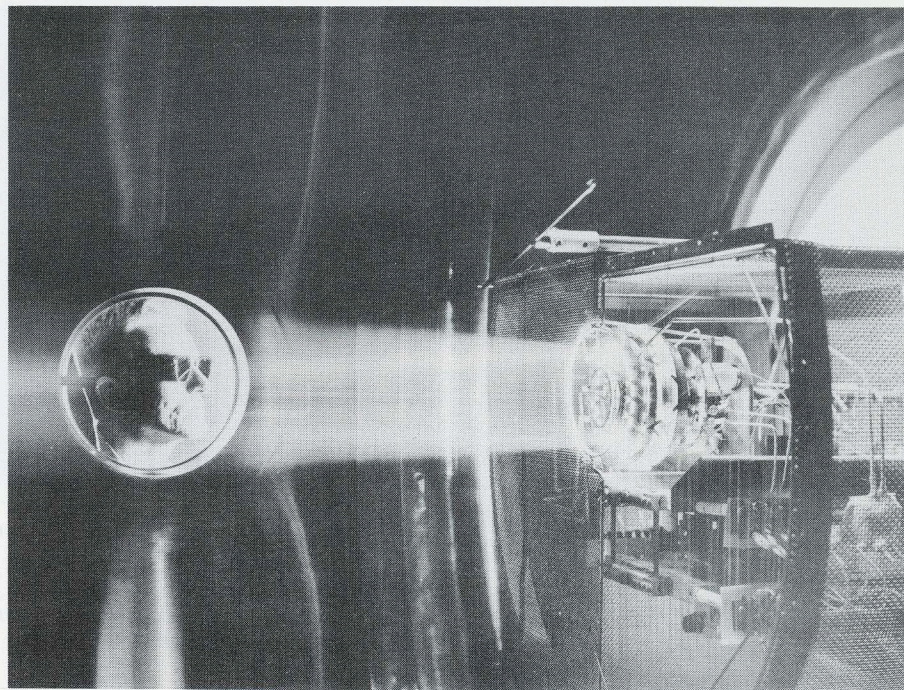
These projects are aimed at developing a world-wide communications system.

American Telephone and Telegraph Company's satellites are due for launching next April and October. A satellite built by Radio Corporation of America for NASA is expected to be launched next July. Hughes Aircraft Co. has also made plans to launch a satellite.

AT&T's satellites are to be built at its own expense and placed in orbit under a contract with NASA. The contract covers the launching of two to four satellites and stipulates that all information obtained from the experiment be made available to the Federal Space Agency.

The 125 to 150-pound sphere-shaped satellites will carry instruments capable of handling different kinds of communications. Launched astride a Thor-Delta Rocket, they will go into orbit ranging from 600 miles at the nearest point to 3000 miles out in space.

The RCA-built satellite is similar in function to the privately owned ones.



**SPACE PROBE POWER** — The eerie glow of ionized atoms shooting out of this working ion engine is viewed through a porthole in a space simulation chamber.

### ION ENGINE

(Continued from page 1, column 4)

mented space probes, driven by ion engines, may be expected much sooner. The first small probes toward Mars and Venus, or simply into deep space, will probably be launched during the second half of this decade."

### Energy Is Nuclear

The primary source of energy for the ion engine in outer space will be a nuclear reactor, the energy from which is converted to electricity through a heat-exchanger and electric generator. NASA and the Atomic Energy Commission presently have under development such a nuclear-electric power generating system.

Here is a description of the ion engine and how it operates by Dr. Malcolm R. Currie, associate director of the Hughes laboratories:

"The propellant used in this type

of engine is cesium because of all the possible chemical elements cesium atoms are most easily converted into ions.

"This propellant is stored in a reservoir from which cesium vapor is diffused through a hot tungsten element which ionizes the cesium by a process known as contact ionization. There then follows a system of electrodes to which voltage is applied in order to accelerate the ions to a very high exhaust velocity.

### Neutralization Is Important

"Finally, the high velocity ion beam passes through a neutralizer region in which electrons are injected into the ion beam to provide space-charge neutralization of the electric field associated with positive cesium ions."

Ejected at extremely high velocities, the cesium ions provide propulsion as do the gases from an ordinary jet engine.

## SERIES OF NEW MOLYBDENUM-TECHNETIUM ALLOYS FOUND

The discovery of a series of new alloys made of molybdenum and technetium was announced recently.

Cryogenic experiments showed that these new alloys, which are very ductile, and so can be drawn into wire, become superconducting at temperatures higher than for most other alloys. Dr. B. T. Matthias, Bell Telephone Laboratories, reported his experiments showed that an alloy of molybdenum-technetium is superconducting at temperatures near 16 degrees K. (Technetium is a man-made element.)

### Magnet Design

This new development will make possible a great reduction in weight, size and power requirements. In magnet design. A superconducting electromagnet can be compared to a more conventional magnet using copper as the conductor. Such a conventional magnet presently in operation at Bell Labs requires a power supply and cooling equipment which literally fills several rooms. While in operation it uses thousands of gallons of cooling water per hour to carry off the heat of 1.5 megawatts of electric power in copper wire; this figure is 25 per

cent of the total amount of power consumed. By contrast, a superconducting solenoid magnet of molybdenum-technetium, and producing a comparable field, would not consume any electric energy once the flux is established.

Meanwhile, a technique has been developed which opens the way to widespread practical use of crystalline niobium-tin, a compound superconducting material recently found to be uniquely adaptable to the construction of very powerful electromagnets. At very low temperatures the resistance of a wire of niobium-tin drops nearly to zero, and once started a current flows indefinitely. This makes it possible to generate and sustain very strong magnetic fields without any power except for a small initial voltage to start a current flowing, and except for considerable refrigeration power to keep the magnet at a nearly absolute zero temperature.

The importance of the niobium-tin compound lies in its unusual properties as a superconductor. This superconductive property of this compound does not disappear in the presence of a strong magnetic field as is the case with previously used materials.



# ORBITING DIPOLES WILL NOT INTERFERE WITH ASTRONOMY

The controversial project of a globe-girdling belt of orbiting "needles," or dipoles was launched as a communication experiment. The package was carried aloft by Midas IV satellite to form a wide reflective band. The belt will not interfere with astronomical observation anywhere in the world, the Space Science Board of the National Academy of Sciences announced.

Dr. Jerome B. Weisner, President Kennedy's special assistant for science and technology, said no more dipoles will be put into orbit until results of the first launching, called Project West Ford, are "analyzed and evaluated." He also said "necessary safeguards" will be developed "against harmful interference with space activities or with any branch of science" before any decisions are made on follow-up experiments.

### Astronomers Concerned

Astronomers had expressed concern that dipole reflections might interfere with research on such astronomical phenomena as light signals from stars and radio signals from objects in the heavens.

A dipole is a tiny strip of copper wire acting as a radio antenna. Each strip is seven-tenths of an inch long and one one-thousandth of an inch in diameter.

To see if dipoles can be used as relay devices in long-range communications, the Government

launched 350,000 of them in a polar orbit to form a belt around the earth. They were sprayed into space, about 2,000 miles out, by an ejection mechanism as the carrier satellite went into orbit. The riding payload weighed about 75 pounds.

In 60 days, the dipoles are expected to condense into a circling belt some five miles high and 24 miles thick. They will be pretuned to reflect radio waves at 8,000 megacycles.

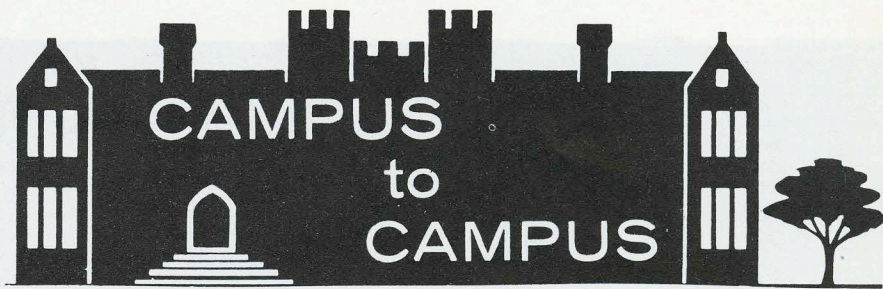
### Later Belts

If the system proves practical later, belts could make available a part of the crowded radio spectrum not now usable for long distance communication.

The Board emphasized that the West Ford Project is intended to be "purely experimental" and not an operational system.

The Lincoln Laboratory of the Massachusetts Institute of Technology, Cambridge, Mass., is in charge under Government auspices. The Air Force provided the Midas IV early warning satellite aboard a two-stage Atlas-Angena B rocket. The dipoles were riding piggy-back on the Midas IV satellite, which circles the earth every 2 hours and 52 minutes.

The initial belt will be in an "essentially circular" orbit, and is expected to last "a few years." It was also described as no more hazardous to spacecraft than are micrometeorites.



The recently-held 1961 Cryogenic Engineering Conference at the **University of Michigan**, Ann Arbor, underlined the increasingly important role of this new science in many fields.

The Systems Research Center of **Case Institute of Technology**, Cleveland, has received a grant for a year's study using computers to attack chronic diseases.

The **University of Pennsylvania's** Moore School of Electrical Engineering was recently host to more than 100 faculty members of various schools who attended a Workshop on Systems Engineering in Electrical Engineering Education.

A course in reliability, one of the newest statistical space-age tools, is being offered for the first time this fall by University College, adult education division of **Washington University**.

Rapid growth in the College of Engineering, **University of Rochester**, in the past three years is indicated by the addition of 17 staff members, all with Ph.D. or equivalent degrees, including nine in electrical engineering.

Professional engineers and state and national leaders in government and industry took part in **West Virginia University** programs culminating in the dedication of the

institution's modern Engineering Center on October 6.

A UNIVAC Solid-State Step 80 Tape System computer, first of its kind in use anywhere, has been installed in the **University of Alabama**.

An ingenious new method of studying changes in the ionosphere during eclipses of the sun will be used by **Pennsylvania State University** scientists under a National Science Foundation grant. An analog computer will correlate old ionization data with new during the rapid changes of an eclipse.

1961 engineering graduates of **Illinois Institute of Technology** received an all-time high in average beginning salaries, earning approximately 5 per cent more than their counterparts in 1960.

Vibration test systems for environmental engineering education are now in operation at the **University of Southern California**, **Yale** and **Polytechnic Institute of Brooklyn**.

An intensified 10 day short course on "Engineering and Management" has been scheduled by the **University of California** Extension beginning January 22.

**Northwestern University** has joined a select group of perhaps a dozen U. S. engineering schools offering curricula in bio-medical engineering this fall.

## Executive Lists Handy Hints To Beginning Engineers

Some handy hints to young engineers were offered by Robert Powell, manufacturing superintendent of Monsanto Chemical Co., in a letter printed in *Chemical Engineering* magazine.

The following ten points of advice were given by Mr. Powell:

(1) Get the "notebook habit." Some jobs are quicker done than written down, but not many. Keep your supervisor well enough informed to do his job.

(2) Learn from the mistakes you make. Dare to conform and dare to be different.

(3) Learn to do things with your hands.

(4) Don't be afraid to ask questions of other operators, or of anyone else for that matter.

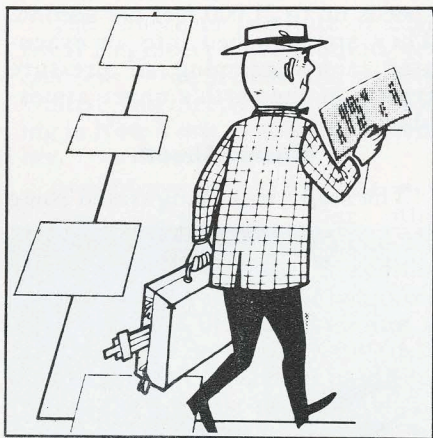
(5) The most important ability you must develop is the art of handling people.

(6) Do not be unduly critical of the mistakes of others. Do not expect others to use better methods and skill in human relations than you are capable of and willing to apply to yourself.

(7) Never underestimate the "power" that is in your hands just by virtue of the fact that your employees want to please you. Do not be afraid of showing displeasure, even to the point of getting mad.

(8) Develop the art of knowing which things should come first.

(9) Learn to sell yourself and



your ideas. No idea, however meritorious, will accomplish anything until sold to the right persons.

(10) Expect to make decisions. "Decisive" is an important word in the management vocabulary and much credit is properly due the man who makes good decisions.

### Solution To Puzzle, Page 3

It is an intermittent "compass-motor." The earth's magnetic field as stator moves this rotor, which is magnetized during about one-fifth of its rotation, by contact between the off-center vertical wire and the flexible horizontal wire. The circuit is completed through half the rotor and the supporting pivot. Best relation to earth's field is found by trial.

## TANTALUM CARBIDE FOR ELECTRIC LAMPS

By using tantalum carbide instead of tungsten in electric lamp filaments, a bulb that gives one-half again as much light and lasts up to twice as long has been produced.

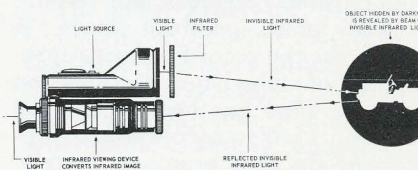
Research on the new high brilliancy lamps was reported in Montreal to the International Union of Pure and Applied Chemistry. Although not yet manufactured, the new lamps are expected to be particularly useful in projectors for slides and films because the screen brightness depends on the actual brightness of the filament's surface.

**6,000°F**

The new tantalum carbide filament burns at a temperature of about 6,000 degrees Fahrenheit, whereas ordinary projector lamps burn at about 5,500 degrees Fahrenheit. The new lamps burn 24 hours, it is claimed, compared with 10 or 12 hours of presently used lamps.

One of the problems in the perfection of the new lamp was to find an atmosphere that would allow tantalum carbide to be treated to high temperatures and remain stable. The inert nitrogen-argon atmosphere used in tungsten lamps was not satisfactory. Suitable gaseous atmospheres consisting of hydrocarbons and hydrogen were devised.

**To All Non AIEE Students:** Ask your faculty Branch Counselor to supply an application blank and endorse it. If you join at the beginning of the college year (up to February 1) the fee is \$2.50, which covers your membership to the following May 1. If you join after February 1, your dues of \$5.00 covers your membership until May 1 of the following year.



**THIS INFRARED** viewing device enables combat troops operating in total darkness to see without being seen. The compact unit is a complete self contained monocular infrared image converter tube, battery, solid state power supply, infrared flashlight, and carrying case. It is called a *Metascope* by Varo Inc. who developed it for the U. S. Army.





# BROADCAST ENGINEERING

by Frank L. Marx  
American Broadcasting Co., New York

(This discussion with bibliography is the fifth of a series.)

There are now operating in the United States over 3,000 radio broadcasting stations and more than 500 television broadcasting stations. These transmitting facilities plus their connecting networks and the many millions of receivers constitute the broadcast plant which furnishes information and entertainment to the people. The design of all parts and future improvements fall within the field of broadcast engineering.

Beginning in the early 1920's, individual radio stations sent out regular programs to audiences who received them with rudimentary equipment, very often listening with earphones. During the years better transmitters, much better receivers, and network station connections added to the service given the listening audience. Receivers for automobile service became practical. Smaller tubes and other components, and especially transistors, made possible the compact portable and pocket sets of today.

### New Era

The inauguration of wide-swing FM broadcasting under the leadership of Edwin H. Armstrong opened a new area of high-fidelity sound broadcasting. A further benefit here is expected very soon in the form of stereo operation, for which technical operating standards are awaiting action by the Federal Communications Commission.

Closely related to broadcasting, and generally considered in the same engineering field, is sound recording by disk or tape and the associated high-fidelity activity. Improved amplifiers and speakers afford a truly realistic quality of reproduction.

### Television

Television began its march as a major industry in 1948. In these few years minor miracles have been wrought in the matter of technical developments and applications. A nation-wide network of circuits for the transmission of television programs has been created capable of supplying three simultaneous network programs. A system of color television has been created making possible programs in color which can also be received by existing monochrome receivers and require no additional spectrum space. A system for the recording and reproduction of television pictures on magnetic tape has been developed which bids fair to revolutionize program production practices in television and probably in the motion picture industry as well.

### Other Developments

In addition to these major developments there have been countless lesser developments and improve-

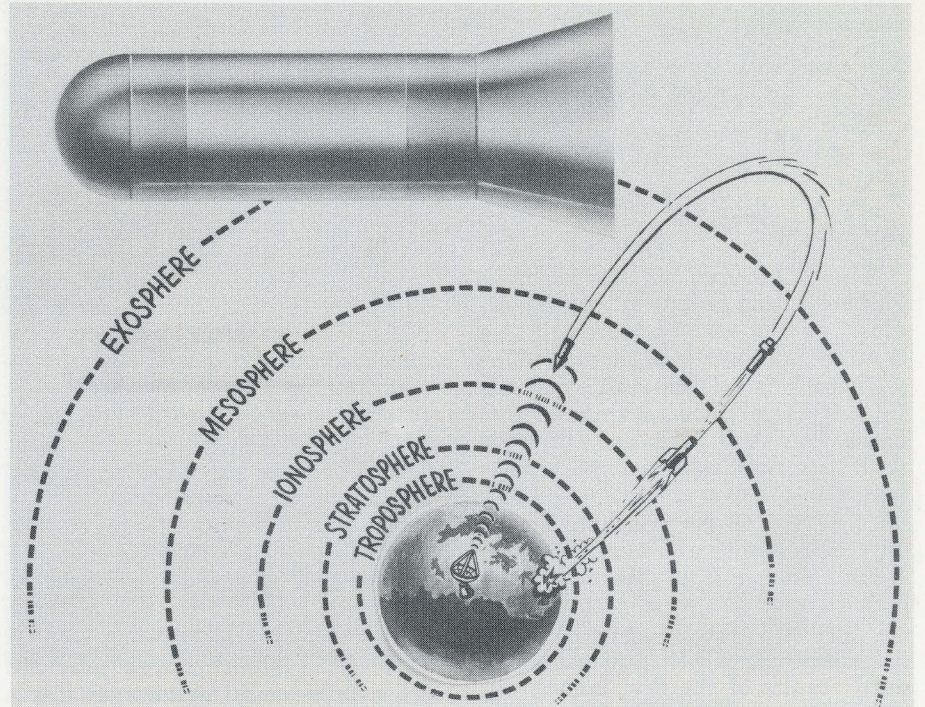
ments in equipment, systems, methods of measurement and operating techniques which are the result of thought and effort by engineers in all segments of the industry. The vidicon, a new type of camera tube, has been developed using photo-conduction rather than photo-emission principles. For the transmission of motion-picture film by television the vidicon is simpler, smaller, better and less expensive than the old iconoscope, which is, therefore, rapidly being replaced by the vidicon. High-power high-frequency tubes, and the transmitters to use them, have been built to provide better television service to more people. With bigger transmitters have come higher-gain antennas with shaped patterns to meet service problems in different areas. Techniques and instruments for testing the performance of television equipment and systems have been improved. It is now possible to determine the frequency, phase, and linearity characteristics of a complex system while programs are being transmitted by inserting test signals in the vertical retrace period. Semiconductors are helping to reduce maintenance problems by replacing tubes in power supplies, amplifiers, synchronizing generators, switchers, and many other elements of the broadcast plant. The examples are almost endless.

### Over The Horizon

It should be clear that with such a recent history of intensive technological development it is unquestionable that broadcast engineering will continue to make great technical advances and extend its service to the public. Just over the horizon are such developments as the further application of automation to broadcasting, the development of new transistorized equipment for video and radio applications and the extension of long-distance relaying of programs on an international scale by satellite repeater or other means. Yet it is always true that cost is frequently as important as the technical characteristics in determining the applicability of a new device at a given time.

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Communications with an actual re-entry vehicle is shown in the illustration above, with the test projectile used in the simulation program appearing at top left. (See article below.)

## Reentry Of Space Vehicles Simulated By Scientists

Scientists are simulating the re-entry of space vehicles into the earth's atmosphere at "altitudes" of 20 to 60 miles to investigate re-entry communications problems.

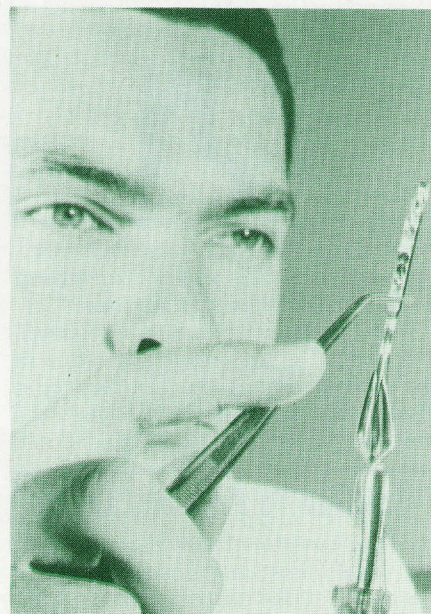
The simulation is part of a study into the effects of the flow of ionized gases around re-entry vehicles upon radio transmission to and from such vehicles.

The study is being conducted by the Applied Research Laboratory of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc., and the Canadian Armament Research and Development Establishment (CARDE), Valcartier, Quebec.

Re-entry conditions are simulated at CARDE by firing small free-flight models of re-entry vehicles from a "light gas" gun at speeds up to 21,000 feet per second. They are launched into an evacuated tank containing air pressure typical of the earth's upper atmosphere.

### Plasma Sheath

The study was inaugurated some



PROBE — Engineer examines a micro-minaturized medical probe developed by Hughes Aircraft Co.'s research laboratories at Malibu, Cal. The probe consists of a tiny P-I-N junction radiation detector at the upper tip which can be contained in a 3mm catheter for insertion into a human vein. Below the detector tip are complete electronics necessary to operate the unit as a recording instrument or in telemetry.

two years ago because of communications problems created by the "plasma sheath" — an electrical conductor created around high-speed re-entry vehicles by compressed and heated air.

The "plasma sheath" is formed when the velocity of re-entry vehicles exceeds about 10 times the speed of sound. Radio signals transmitted through the sheath are substantially weakened, thus blacking out the communications link with re-entry vehicles.

### Microwave Receiver

For the simulation program, a microwave "crystal" radio receiver and a telemetering transmitter have been built into the projectile-type model — which is two inches in diameter and is subjected to shock loading in excess of 150,000 times the force of gravity when fired down the ballistic range.

Upon being launched, the equipment within the projectile receives and transmits signals through the "plasma sheath" to and from communications equipment in the range. Resultant data is recorded on magnetic tape for evaluation and study.

### Solution to crossword puzzle, page 3.

S	T	R	O	B	O	S	C	O	P	I	C
U	N	I	T	S	C	A	L	E	O		
P	T	S		T	C		T	S	I	N	
E	E		R	I	C	H	M	O	N	D	
R	E	T	A	I	L		I	C	I		
H	I	T	A	L		L	H	T			
E	T	M		L	A	D	D	E	R	I	
T	I	E	S		T	E		N	O		
E	T		H		O	R		G	A	I	N
R	A	D	I	O	R	E	L	A			
O	N	C	E		R	I	T	E	L		
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