EE DIGEST

CURRENT DEVELOPMENTS IN ELECTRICAL ENGINEERING AND SCIENCE

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FINAL TEST FOR NAVY'S POWERFUL L-F STATION

A low-frequency radio station, one of the world's most powerful, has gone into the final testing stage by the U.S. Navy. The station is capable of contacting units of the fleet including submerged Polaris submarines in any part of the North Atlantic or Mediterranean.

The all-purpose fleet and submarine communication system, whose antenna arrays resemble a gigantic spider web spun in the sky, operates in the very-low-frequency range, 14-30 kc. The transmitter power is rated nominally at 2 megawatts.

An antenna radiation efficiency in excess of 50 per cent is expected. Until now the efficiency of very-low-frequency antennas ranged from 20-25 per cent. The closest competitor for the new Naval radio station was the one built by the Germans during World War II for contacting their submarines.

It was reported that the Goliath, as the system was called, had been confiscated by the Russians and moved to the vicinity of Stalingrad where it is now operating.

Information destined to any submerged submarines carrying Polaris missiles must be transmitted on a very low frequency carrier because of its ability to penetrate salt water.

A very-low-frequency carrier offers another advantage in the fact that it propagates along the curvature of the

(Continued on page 7, column 3)

AIEE National Exposition Will Be Held In 1962

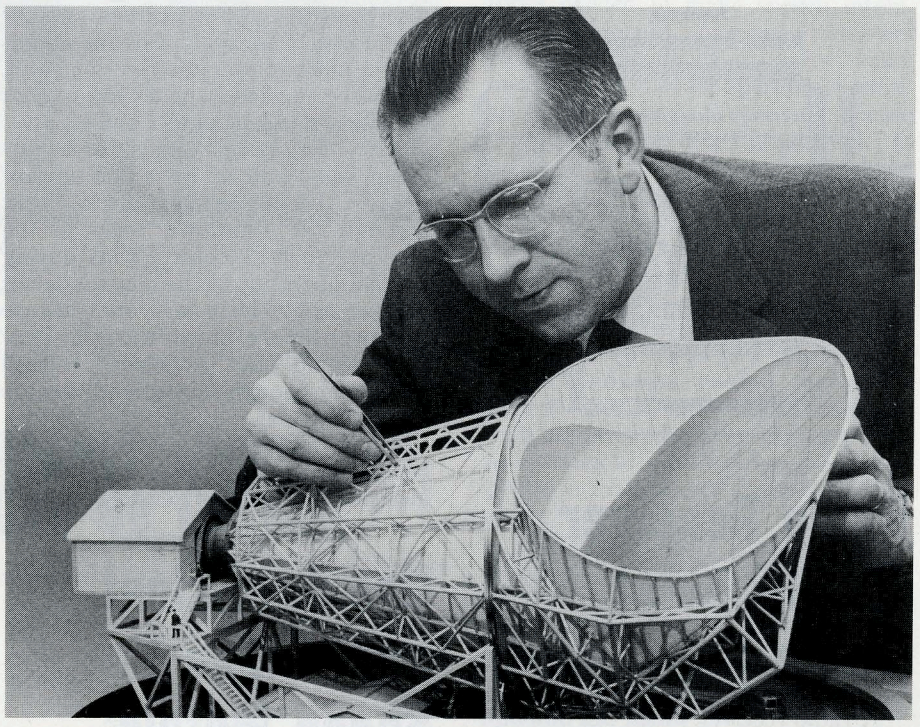
The AIEE has announced its sponsorship of the first industry-wide, national Electrical Engineering Exposition to run in conjunction with the Institute's 1962 Winter General Meeting.

This horizontal, across-the-board Exposition, to be held January 29 — February 2, 1962, at the New York Coliseum, will display the products and services of every branch of the industry — from the generation of electric power to its utilization in industry, controls, communications (by wire and radio) and in space. The keynote will be electricity and electronics.

The Exposition has been developed to supplement and enhance the full range of the educational and scientific value of the technical sessions at the Winter General Meeting.

AIEE Student Branch members will be admitted free of charge to the Exposition, which is held only once in every two years.

HORN OF PLENTY



BIGGEST HORN — A Bell Lab engineer checks model of the "world's biggest horn" which will be built this year near Rumford, Maine. The antenna, 177 feet long and housed in a "radome" 210 feet across and 161 feet high, will be used for experiments in sending television and high-speed data as well as telephone calls across the Atlantic by way of satellites (see article to right).

A radio-telescope as big around as a stadium including a football field will be in operation in West Virginia, perhaps by 1962. This monster instrument, nearly as high as a seventy-story building and 600-feet in diameter, will be the world's largest steerable telescope when it is completed.

Radioastronomy is a very young science which has grown in tremendous steps in the past two or three decades — as the construction by the Navy of the great new instrument suggests.

The science dates back to the observations by Karl Jansky in 1933 that radio signals were coming from the Milky Way. Actually, however, the past one or two decades have seen all the big developments in radioastronomy and the constrution of ever-larger telescopes for receiving signals from outer space.

The purpose of building big radio-telescopes is the same as in the building of big optical telescopes. The reflector in the radio-telescope collects electromagnetic radiations just as the mirror in an optical telescope gathers light. A bigger reflector gathers more information in either radio or optical astronomy.

The largest presently-operating steerable radio-telescope is the 250-foot British instrument at Jodrell Bank. Russia and other nations have large non-steerable instruments which are trained around the skies somewhat with the motions of the earth.

Recent British experiments suggest the utility of radioastronomy and some of the complications which can ensue. Dr. Martin Ryle, Professor of Radioastronomy at Cambridge University, recently told the British Royal Astronomical Society that signals received from some eight to ten billion light years out in space have disproved the "steady state" theory of the universe.

The steady state theory holds that creation of matter is constantly going on and that the universe always has and always will expand as new matter is formed. This theory is contrary to an opposing theory that the universe began with a "big bang" some number of billions of years ago and has been evolving regularly since the moment of the "creation."

Professor Ryle's observations were that there are more radio sources — measured at a few hundred megacycles — out in space than there should be. This he interpreted to mean that the steady state theory is wrong.

This view has been challenged within the past few weeks by Professor Thomas Gold, now at Cornell University in Ithaca, N. Y., who along with Professors Fred Hoyle and Hermann Bondi of Cambridge, is one of the originators of the steady state theory.

Professor Gold holds that the "crisis in cosmology" brought on by Pro-

(Continued on page 5, column 1)

WORLD'S LARGEST ANTENNA HORN TO BE BUILT

The world's largest antenna horn, designed as part of a new experimental space communications ground station, will soon be built in western Maine.

The horn, a 177-foot long, 94-foot high rotating antenna on a 250-ton steel and aluminum structure, will be protected from wind and weather by the largest inflated earthbound structure ever made.

The antenna will do two things: (1) Beam signals to a satellite, which will relay them to Europe, and (2) serve as a giant ear trumpet to scoop up faint signals that are relayed back from Europe by way of the satellite.

Workmen are now clearing parts of a 1000-acre tract near Rumford, Maine, for the structure. Developed by the Bell Telephone Laboratories, the antenna will be ready next year.

Construction of this antenna will be a major step toward linking the countries of the world with telephone, data and television channels via satellites.

Its spherical cover, or "radome," supported by air pressure, will be 210 feet wide, 161 feet high — about as high as a 13-story building. The radome is designed to weather the strongest anticipated gales. Its skin will be 20 tons of synthetic rubber and fabric a sixteenth of an inch thick which cover three acres if laid out flat.

Direct-Conversion Generator Tested

A nuclear thermoelectric generator that converts heat directly into electricity is being tested.

The device is ten inches high, sixteen inches in diameter and weighs less than forty pounds. Said to be capable of developing approximately 150w, it is designed to use radioactive isotopes of Curium 242 as heat sources.

The generator's 144 small semi-conductive elements are heated by the isotopes to a temperature of 1000 degrees F. Finned heat exchangers, which cover the generator-like porcupine quills, keep the ends of the elements farthest from the heat source at a temperature of 300F. The generator was said to have the highest efficiency of any direct-conversion electrical power device of comparable size.

Designated the NAP-100, it is another step in Air Force utilization of thermoelectrical devices for direct conversion of nuclear energy.

A product of Westinghouse, the NAP-100 is being tested at the Kirtland Air Force Base in Albuquerque. It is expected to operate a full year without refueling.

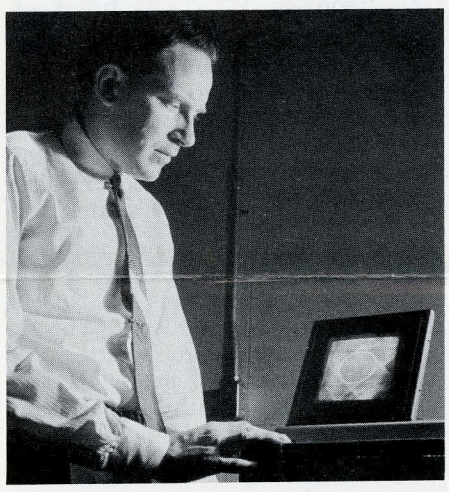
1st Use Of Nuclear Cells To Be For Satellite Power

The first application of nuclear fuel cells will probably be as a satellite power supply, according to a prominent researcher.

The nuclear fuel cell system most often studied today, lithium hydrogen, is not competitive with present mechanical systems in weight. It is, however, in its infancy. It has been estimated that the LiH system can supply 3 watts/lb. in the 500 watt class for space power missions.

Regeneration of materials by feedback of energy is basic in nuclear fuel cells but no system of regeneration has yet been developed that can closely approach maximum thermal efficiency. This is because electrochemical cell losses tend to be high and the most common method of regeneration of gas and liquid phases reduces the effectiveness of any intermediate heat exchangers.

In all likelihood, R. E. Henderson, physicist at General Motors, told the American Power Conference, military uses such as power supplies for remote bases will follow the space application.



Tiny Electronic Panel Produces Moving Image

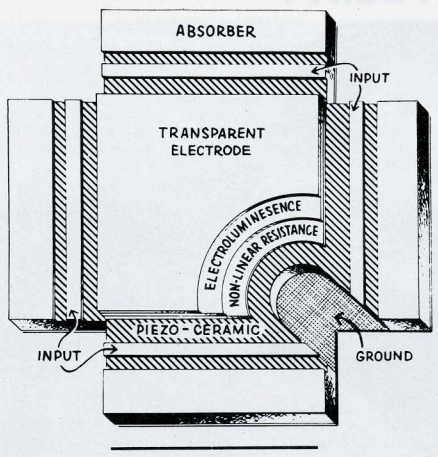
An electronic panel less than one-half inch thick that produces a moving, lighted image is described as an entirely new combination of electrical phenomena that have been in general use for a number of years . . . piezoelectricity and electroluminescence.

The device consists of a thin, flat panel composed of piezoelectric ceramic material, one surface of which is coated with a layer of electroluminescent material. When voltage signals are applied to several electrodes on the edges of the flat piezoelectric panel, traveling acoustical waves are introduced into the ceramic material. Electric fields which accompany these acoustical waves interact with the electroluminescent layer to produce a spot of illumination on the panel.

The position of the spot is controlled by varying the relative timing of the electrical pulses to produce an electronic wave pattern. The light intensity of the spot is modulated by an electric field applied to a transparent conductive layer covering the electroluminescent layer.

As timed input signals are applied, a series of light spots or lines are produced which can form an image. The image can be made to move about the panel by varying the timing of the signals.

One advantage of the device is its ability to display an image on a thin flat panel, while conventional electronic display devices use a cathode ray tube. Earliest application of the display device, as seen by General Telephone and Electronics Laboratories, where it was developed, is in military and laboratory devices.



Radio Receiver Can Pinpoint Space Capsule

A radio receiver which can pinpoint the spot where an astronaut has landed in a space capsule after orbiting the earth has been developed.

The receiver is used by patrol aircraft to pick up signals from a radio transmitter located in the space capsule. The received signals are displayed as a spot of light on the face of a small "picture tube" on the receiver.

The equipment was developed by International Telephone & Telegraph Corporation.

The radio receiver is designed to receive various types of signals known as continuous wave (CW) signals, single pulse signals, and correlated double pulses. This versatility makes the equipment more reliable and results in greater safety for the astronaut. If one type of signal reception become inoperative, another may be used to locate the capsule.

Solution Is Found For Microwave RFI Problem

A solution to the problem of radio-frequency interference (RFI) from high-power microwave transmitters has been found.

A technique has been perfected for making waveguide power filters which effectively eliminate RFI caused by harmonics. Working on a principle analogous to that of the common automobile muffler, engineers at GE's Power Tube Department have made the new filters, which absorb the unwanted harmonic signals produced by all transmitting tubes, but still allow the intended fundamental frequency to pass through with its power undiminished.

The harmonic filters also serve to increase the power handling capacity of the waveguide system on the output side of the tube by eliminating waveguide arcing which results from harmonics.

Devise System For Reactor Safety

Underlining the current concern in the United States about the safety of nuclear reactors (three persons were killed recently in a nuclear reactor accident in Idaho), a safety system has been patented that prevents a nuclear reactor from shutting down when the power plant fails. In a system that discriminates between critical reactor faults which definitely warrant a shutdown, and a power distribution fault, the safety device switches the reactor over to a stand-by power outlet.

The safety system consists of a shutdown relay and at least one control relay. Alternating current is sent through the shutdown relay to the nuclear reactor's control rods during normal operations. The control device has two relays instead of one. In case of power failure, one of the relay contacts would have a delayed release time, long enough to permit a change of power outlet.

Patent rights to the invention have been assigned to the British Thomson-Houston Co. Ltd. of London.

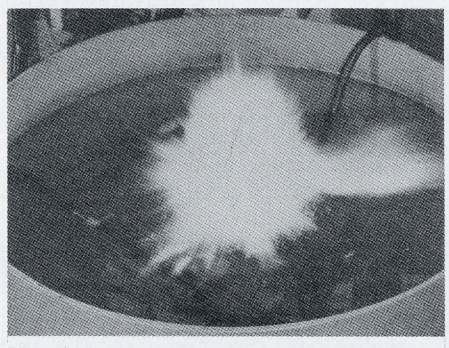
Use Electrical Explosions To Shape Metals

Underwater electrical explosions are used in an economical new process to mold hard-to-form metals.

The process, whose uses were forecast last fall (see EE Digest, Vol. I No. 2), eliminates the need for TNT, dynamite, or other chemical explosives in forming such metals as titanium, tungsten, and stainless steel. By this method, described as "capacitor discharge electro-spark forming," metal pieces up to ten inches in diameter and one-sixteenth of an inch thick have been processed.

Molding is done at room temperature without pre-heating. The metal to be shaped is placed in a die under water. A build-up of electrical energy produces an explosion that directs high intensity shock waves against the metal to be formed. Impact of the shock waves causes it to take the shape of the die. Air is removed from the die to prevent surface irregularity.

Other metals successfully shaped with the GE-developed process are molybdenum, niobium, and certain beryllium alloys.



Metal pieces formed by electric-spark method.

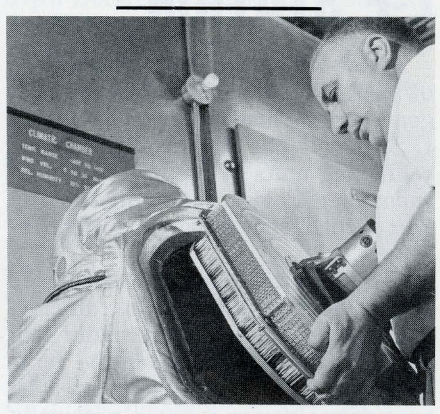
Computer To Speed Overseas Messages

Electronic data processing machines can now be used to speed up international commercial communications.

Such a computer system will be launched by The Radio Corp. of America in 1962, at its New York communications headquarters. Data processing equipment in the new system will occupy about one-fifth the space needed for equipment to do the job as it is done now.

The special data processor will be similar to the 601, largest present RCA system. It will operate in micro-seconds, and its message switching speed in milliseconds. Buffers will pace the machine to the speed of wire and radio messages. A second duplicate system will stand by in case of difficulty.

RCA handled more than 25,000 overseas messages daily in 1960, as contrasted to 1000 a day in 1920.



All-Weather Suit Resists Extremes In Temperature

A self-contained air-conditioned suit has been developed which can keep the wearer comfortable in outside temperatures ranging from 40 degrees below zero to 135 degrees Fahrenheit.

The experimental model suit is heated or cooled by thermoelectricity. Cooling is accomplished by passing an electric current through thermoelectric couples made of semi-conductor materials. The heating or cooling, done automatically when the current is reversed, maintain a temperature of about 80 degrees F. inside the garment.

During cooling, the current flow causes one end of the thermoelectric couples to cool, thus lowering the temperature of the heat exchanger inside the suit. After heat removed from the cool side flows through the thermoelectric elements to the hotside heat exchanger, it is dumped to the atmosphere by a small fan. Another fan, mounted on the same shaft, circulates the cool air within the suit. The only moving parts in the system are two small fans. A battery pack in front provides power to make the suit completely portable.

The suit was developed by engineers at Westinghouse Electric and the U. S. Naval Supply Research and Development facility.

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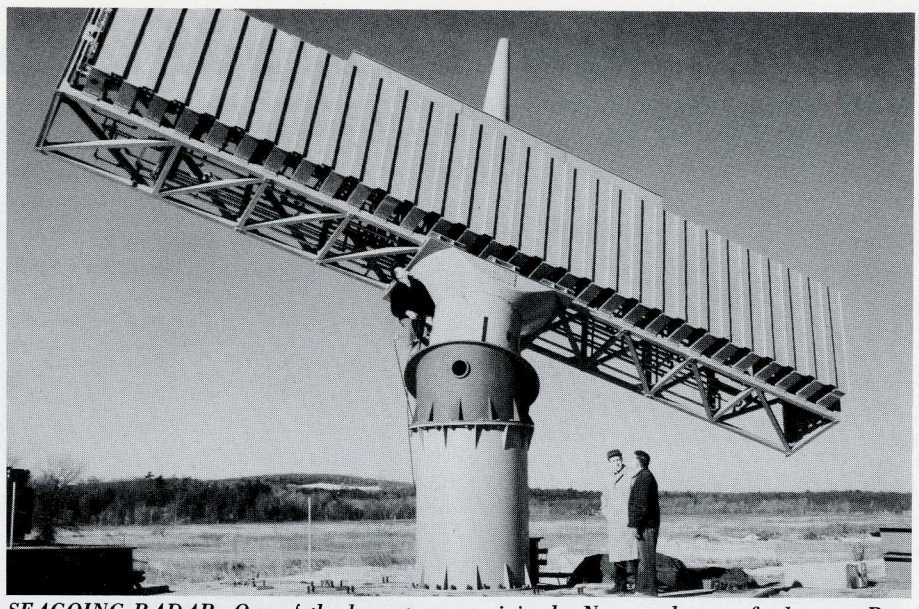


SEAGOING RADAR: One of the largest ever to join the Navy undergoes final test at Raytheon Company's Equipment Division facility at Wayland, Mass. The 10-ton system and its 40-foot antenna, shown here, are designed to baffle enemy attempts at jamming and to give early warning of air attack. Inside the antenna is a plumber's maze of pipes — transmission lines to carry radar waves to and from the many horns. Key to the radar's long range and flexibility is a power tube which boosts output many times, yet maintaining operational stability.

New Experiments Support Theory That Radar Beams Can Be Curved

The theory that radar beams can be curved seems to have been further demonstrated in recent experiments.

The theory maintains that there are radar "pipes" in the sky, arching into space and then back in the opposite hemisphere. If a radar beam of suitable frequency is fired into such a duct, it is trapped like water in a hose.

The magnetic force lines extending out from near the earth's poles may serve as periscopes that reach to the frontiers of the earth's magnetism. Whether or not signals from the cosmos are coming from these ducts is unknown.

In experiments by Dr. Roger M. Gallet, at the National Bureau of Standards in Boulder, Colorado, a radar pulse was beamed at a point 71 degrees above the horizon near Washington. Within a fraction of a second after each pulse came an echo from near Cape Horn. The round trip distance traveled by the signal along its invisible pipe was about 30,000 miles. This distance varied by several thousand miles during a three-month period. Apparently events on the sun or other disturbances were squashing or stretching the earth's magnetic field, changing the length of the pipe.

PIPES SHORTENED

This denting of the earth's magnetic field shortens the pipes through which the guided radar flows. The result is that the radar "range" of South America, as observed in this way, becomes several thousand miles shorter — an effect already observed in the preliminary experiments.

Gallet believes that radar pipes might be as narrow as 200 yards, depending on the radar frequency. When the signal re-enters the atmosphere at the far end of its arc, it spreads, so that at ground level, it can be heard within a radius of about 30 miles.

Radio signals at the frequencies used for long-distance communications are bent back to earth by regions of great electron density within a few hundred miles of the earth's surface — the radio reflecting layers of the ionosphere.

This effect makes possible transoceanic communications. Signals above 15 or 20 megacycles normally ignore these electron layers and shoot straight out into space. However, it now appears that those in the marginal frequencies may be channeled in radar ducts or "pipes." The 71 degree point was selected because, according to Gallet's calculations, this was where the open end of the radar pipe was suspended.

The signals used in this experiment were on 13.5 megacycles at about 150 kilowatts. Gallet hopes to attempt two-way radar exchanges along the magnetic arc linking the Aleutians and New Zealand.

Solid State Device Converts Current

A working model of a high-capacity solid state electronic device for converting direct current to alternating current has been developed.

The device has no moving parts, other than two fans, and it does the work of a 60-horsepower motor generator set which is almost three times as heavy. With a rating of 50 KVA, the new inverter has ten times the power handling capacity of units of this type developed up to now. The 50 KVA inverter will help solve a problem in development work on new power sources. Electric power generated by such means as fuel cells and solar energy is always in the form of direct current. Most applications, however, require that this be converted at low cost into alternating current.

The solid state inverter, which was developed by General Electric's General Engineering Laboratory, should be especially useful because of its low maintenance requirements in isolated installations that must operate unattended. The inverter operates almost noiselessly, an important factor in some military applications.

Actual conversion of power from DC to AC is accomplished by silicon-controlled rectifiers which operate instantaneously and require no warm-up. Compared with other methods of converting electric power from direct current to alternating current by solid state devices, silicon-controlled rectifiers show by far the best promise.

The 50 KVA model has been designed for use in the engineering laboratory, and is housed in a metal cabinet mounted on wheels. The AC power output is provided at frequencies varying from 50 to 500 cycles.

'Compact Voice' Aids Radio Traffic

A device that produces a "compact voice," designed to relieve increasing traffic congestion on radio communications channels, has been developed.

Called a "vocoder," the device condenses a voice by ignoring redundant sounds in speech and transmitting only those needed to make speech intelligible. Therefore, it can use a narrower electronic frequency band for transmitting. The vocoder operates in either an analog mode, to provide speech compression, or in a digital mode, to make voice transmission less subject to interference.

When in use, the vocoder is connected to either a radio or telephone-type transmission system, and a microphone and earphones are plugged into it. When used in the analog mode, the vocoder requires only a tenth of the radio bandwidth needed for speech transmission by conventional methods. In a digital mode, voice is transmitted as a series of on-off pulses which improve reliability and extend effective range.

A ground-based vocoder is now being tested at the Rome, N. Y. Air Development Center. It was developed by Hughes Aircraft under an Air Force contracts.

MIDGET TV-RADAR SCREEN BUILT FOR AIRCRAFT SAFETY

A miniature radar and television screen built into a compact telescope-type case, and designed as a safety device for pilots of small aircraft, was exhibited recently.

In the "Private Eye," the remote screen is a miniature high-resolution cathode ray tube mounted behind a magnifying eyepiece. Although the picture surface is only 6/10 inch in diameter, it is enlarged ten times to the viewer. Because the screen has 900 lines (about three times the number on a television set) it yields a picture of extremely fine detail. The complete unit is 8½ inches long, weighs only 20 ounces, and can be hand-held.

A major advantage of the "Private Eye," in addition to portability, is its ability to operate under bright light conditions that wash out pictures on conventional receivers.

In addition to small planes, use for the device is seen by Westinghouse, its developer, in television-in-the-field, where it could serve as a portable monitor not affected by daylight. Applications might include closed circuit TV systems for automobile traffic control, large construction projects, and three dimensional binocular type display for remote viewing and control in hazardous environments.

New Satellite Ion Fuel Cell Tested

An ion exchange membrane fuel cell that would replace present satellite batteries is being tested.

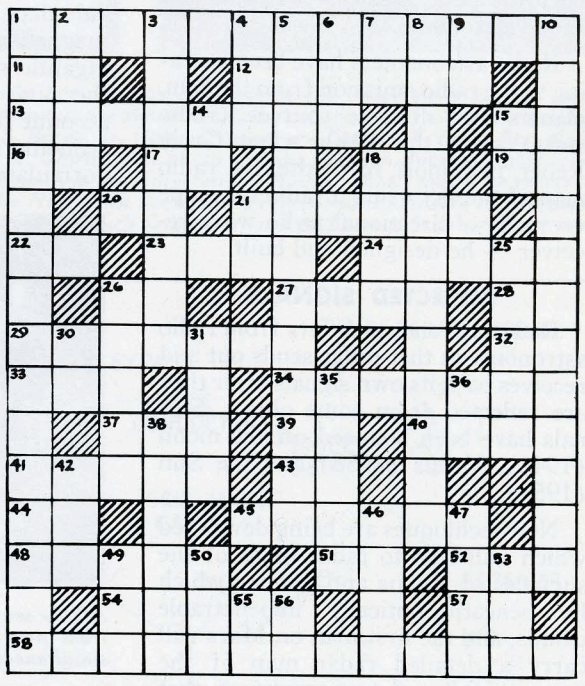
Each cell is composed of a membrane on each side of which there is an electrode. On one side of the membrane there is a supply of hydrogen gas and on the other, oxygen gas. The unequal diffusion rates of the two ionized gases, a dialytic effect, produces electron movement of current. Power output will be 50 watts.

The new cell is expected to produce more power for a longer time, yet weigh less than the present one.

The experimental fuel cells are being developed by General Electric, at the company's Missile and Space Vehicle Command at Philadelphia, under an Air Force contract.

Electro-Technical Crossword Puzzle

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



ACROSS

1. Force due to magnetic potential difference
11. Impersonal pronoun
12. Attack
13. Pact, agreement
15. Prefix
16. Room (abbrev.)
17. Personal pronoun (plural)
18. Type of engineering (abbrev.)
19. Resonant circuit
20. Conjunction
21. Whiten
22. Type of engineering (abbrev.)
23. Part of complex impedance
24. Sound Navigation and Ranging
26. Sketch (abbrev.)
27. Opposite of "short" circuit
28. Preposition
29. Metal framework
32. Conjunction
33. Supporting bar
34. Moving part of relay
37. Dine
39. Beast of burden
40. First 4 letters of Turkey's capitol city
41. Variety of evergreen bush
43. Greek letter
44. Alternating voltage
45. Calm, composed
48. What like charges do
51. Engineering Unlimited
52. Caused by ionization between electrodes
54. Greek classic by Homer
57. Regular Army
58. A conductor one-half wavelength long at a given freq. (2 words)

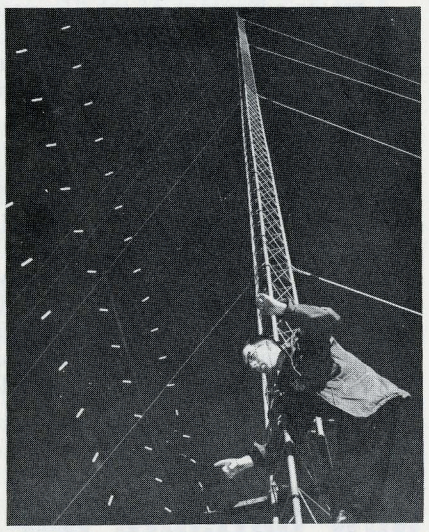
DOWN

1. 1 microcoulomb divided by 1 megavolt
2. Fundamental structure
3. Systems of elements
4. Trans Africa Airways
5. Voltmeter with visual indication
6. Mountain Standard Time
7. Oriental Airways
8. R x C or L/R (2 words)
9. Prefix meaning "non"
10. Condition of electricity at rest
14. Prefix (same as No. 15 ACROSS)
15. (ohms) (ohms) (time)
18. Enclosure
21. College degree (abbrev.)
25. A fastener (2 words)
26. Sword
30. Greeting (slang)
31. Groups, combinations
35. Chemical residue
36. Adjective
38. Author of "Electronic Circuits"
42. Night
46. Female relative
47. Gain, win
49. Sharp pulse on 'scope
50. Girl's nickname
53. Flowed, raced
55. Middle letters of popular student organization (not AIEE)
56. County legal officer (elected)

The solution to this crossword puzzle is on page 8.

RADIO AND RADAR ASTRONOMY ARE SEEN AS

SIGNALS FROM JUPITER RECEIVED BY POWERFUL RADIO TELESCOPE AT YALE



One of 110-foot towers of Yale's new radio telescope.

Construction of a powerful new radio telescope has been completed at Yale University recently, providing astronomers with a highly sensitive instrument for receiving mysterious signals from the giant planet Jupiter, 500 million miles from the earth.

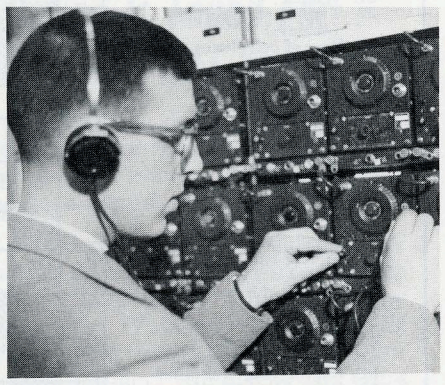
For the past four years astronomers, assisted by a team of Yale students, have kept a frequent vigil listening, tracking and charting Jupiter's sounds. What they hear is an occasional gentle "swish," but far away on Jupiter the "swishes" are actually enormous outbursts packing the wallop of a small atomic bomb.

The new telescope consists of two huge grids, each towering 110 feet high, 110 feet wide and 200 feet long, situated one-half mile apart. The total equipment will be used to study 108 simultaneous frequency channels — eight times as many as Yale's present equipment.

It all began six years ago when radio astronomers in Washington aiming their sensitive telescopes at the sky accidently discovered that Jupiter, for no accountable reason, was putting out enormous bursts of radio energy. The blasts were so loud that if they originated from heat processes, as is often the case, they would correspond to temperatures of billions of degrees.

But Jupiter, astronomers knew, was frigid, located 500 million miles from the Sun, with no significant heat source of its own, its atmosphere far below zero. How then could Jupiter, scientists pondered, be capable of emitting radio noise in the absence of appreciable heat?

Astronomers to date are unable to give a complete answer. They speculate that little of the Sun's output may be trapped by the earth because of its relatively small mass and magnetic field. Jupiter, on the other hand, may be vulnerable because its mass is 300 times greater and its magnetic field may even be 1000 times more powerful than the earth's. This intense magnetism on Jupiter could cause a gigantic spiraling effect of clouds of the sun's charged particles and thus account for the radio bursts. But astronomers are hazy on this and have formulated no definite conclusions.



A Yale senior tunes in on the planet Jupiter from new radio telescope, which has 108 simultaneous frequency channels.

Manned, maintained and largely built by several dozen Yale students under the supervision of James W. Douglas, Instructor in Radio Astronomy, and Harlan J. Smith, Associate Professor of Astronomy, the new equipment has been financed by grants from the Research Corporation, the National Science Foundation and the National Aeronautics and Space Agency.

RADIO ASTRONOMY: OUR NEW EYES IN MODERN TELESCOPY

(Digested from the New York Herald Tribune.)

From the time, early in the 17th Century, when Galileo opened up new vistas in astronomy with his simple telescope, astronomers have tried to picture more accurately and examine more closely celestial objects both near and far. With the building of the Hale 200-inch telescope and the 48-inch Schmidt camera the limit of optical practicality seemed to have been reached. But a new window into space was opened in the 1930s when Karl Jansky, in New Jersey, discovered that our Sun emits radio waves. Thus were born the new "sciences" of radio and radar astronomy.

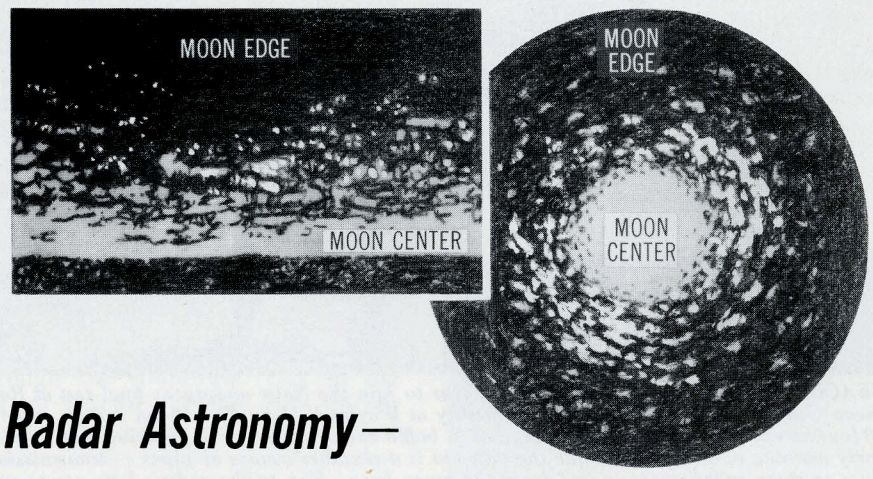
Radio astronomers have been listening to the radio emission from the Sun, planets and discrete sources (radio stars) since the 1940s when Grote Reber, in Illinois, made the first radio map of the sky using a radio telescope — really a directional radio wave receiver — he designed and built.

REFLECTED SIGNALS

Radar astronomy differs from radio astronomy in that radar sends out and receives back its own signals after they are reflected from some object. Signals have been bounced off the moon (1946), Venus (1958) and the Sun (1959).

New techniques are being developed which will lead to radar maps of the surfaces of Venus and Jupiter which lie beneath optically impenetrable clouds, and the first man on Mars will carry a detailed radar map of the "vegetation" and topography of that planet.

To make detailed observations of the planets and to pierce intergalactic space, radio-radar telescopes must be built even larger than the 250-foot-wide Jodrell Bank (England) giant. The U. S. Naval Radio Research Station (West Virginia) has a 600-feet-wide dish under construction and a 1,000-feet-wide dish is planned.



Radar Astronomy— New Light On The Moon

Until recently most of what we knew of the moon came from observing its reflection of sunlight. A powerful new means of moon inquiry is now available. It is the study of the moon's reflection using a different kind of "light"—microwaves, as used in radar.

This moon-echo technique is in its infancy. Already, however, it is apparent that it will provide a means of obtaining information, unobtainable by conventional astronomy, not only about the moon but also about the planets. Nearer at hand, moon echoes will help fill a gap in our knowledge of the earth itself.

One aspect of the study of radar reflections from the moon is the examination of the moon's surface. Such studies give a measure, for example, of the moon's roughness. While roughness has also been measured with optical telescopes, the moon provides an excellent target on which to develop the radar technique, which can then be used to learn something of the surfaces of planets that can't be seen optically. Venus, for example, is obscured by clouds.

DIGEST

Digested from Research For Industry, *Stanford Research Institute, Menlo Park, Calif.*

The moon revealed by radar and the moon seen by eye are very different. This is because of differences in reflective characteristics of visible light waves (one billion megacycles frequency) and radar waves (ten to 3000 megacycles). Because the moon surface is rough, to visible light it appears nearly as a flat reflector. It appears to be uniformly bright over all its surface. At radio frequencies, the signals have more of a tendency at the outside edges to be reflected into space and away from the earth. Thus, in general, to radar, the moon has a bright center, because the center of the moon is nearly at right angles to the earth. This brightness fades gradually to the moon edge, because the increasing angle of the moon surface as seen from the earth directs more and more of the signal into space instead of returning it to earth. Around the central bright portion are many bright patches created by irregularities on the moon surface. This pattern of bright areas changes with time. This is because, although the moon does not rotate, it wobbles (librates) in a complicated manner. At any one time the moon appears to be turning, some portions of the moon moving toward the other and the others away. By the Doppler effect, which is the change in pitch of a signal from a moving object, some prominences appear to radar to be moving away while others seem to be coming closer. Some days later the pattern is different because the motion of the moon changes. This libration of the moon and the ability of radar to detect these irregularities in echo Doppler and amplitude provides a means of gathering useful data about the moon surface.

ELECTRICAL QUALITIES

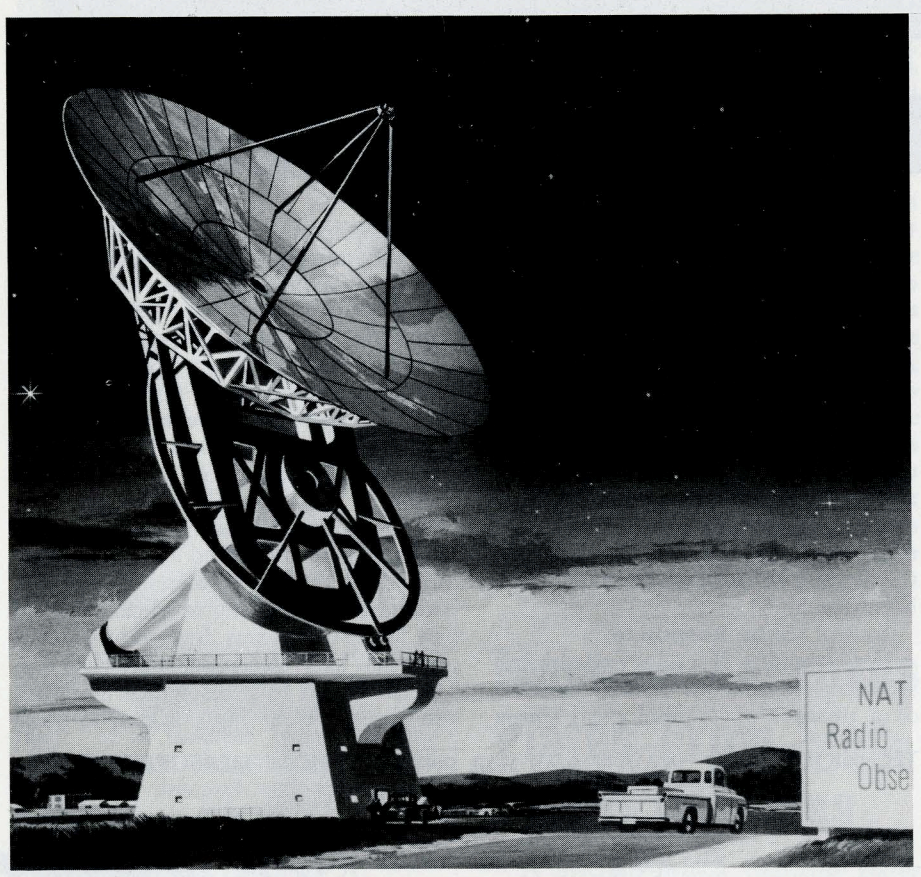
Study of the strength of moon echoes also makes it possible to deduce the reflectivity of the moon's surface. From this a measure of the electrical qualities—the dielectric constant—of the moon surface is obtained. Measurements made to date suggest dielectric constants of about 8.2×10^{-12} farads per meter. Such information is important in designing a communication system using the moon as a reflector. Also, it gives an indication to the materials of which the moon surface is composed.

Use of moon echoes to study the earth's atmosphere have been fruitful. When a radio signal passes through an ionized layer within a magnetic field such as the ionosphere, the polarization of the signal is rotated. From the amount of this polarization rotation the electron density of the ionosphere can be deduced. The electron density of the underside of the ionosphere has been measured by other techniques, but a radar signal in a round trip to the moon passes through the entire ionosphere twice. From this it has been learned that the electron density in the upper portions of the ionosphere is two to three times what was believed.

Only a bare beginning has been made in developing moon-echo techniques. (See next page, column 3.) Use of radars having angular resolution as well as range resolution will further aid in understanding the scattering of radar signals and other bodies. Using radars of much greater sensitivity will allow these moon-echo studies to be extended to investigation of planets in the relatively new field of radar astronomy.

Already it is clear that moon-echo technology will be a most useful means of obtaining information necessary in the burgeoning space age.

SPACE-AGE TOOLS TO EXPLORE THE HEAVENS



This is an artist's drawing of the 140-foot Radio Telescope now under construction at the National Radio Astronomy Observatory, Green Bank, West Virginia.

FEATURE

(Continued from page 1, column 3)

fessor Ryle's belief that the steady state theory is in doubt is not, in fact, a crisis at all. The point at issue is the distribution of radio sources in space.

Within the limits of present-day optical telescopy, it is agreed that matter is uniformly distributed out to a distance of some two billion light years—the distance covered by light traveling two billion years at some 186,000 miles a second. Professor Ryle reported that radioastronomical observations found discrepancies at great distances. More sources were found, in a sky survey by radioastronomy, than might be expected, he reported.

Can't Measure Distance

However, Professor Gold emphasized recently that there is no way to measure distance by radioastronomy at the present time. And he believes Professor Ryle to be wrong in ascribing a distance of some eight to ten billion years to the radio sources he has observed. According to Professor Gold, radioastronomy surveys can now be made by plotting the intensity of radio sources at each frequency against the number at each intensity. When this is done, he maintains, the steady state theory holds that a plot on log-log paper would have a slope of minus 1.5. In actuality, Professor Gold reported recently, the new observations of Professor Ryle are not so far off the ideal line to declare the steady-state theory invalid — as Professor Ryle has done.

Basic Question

Thus radioastronomy at present is in the forefront in investigations into one of the basic questions which face modern science — studies of the possible creation and evolution of the universe as we know it today.

Project Ozma of the National Radioastronomy Observatory was another pioneering investigation in the new science. Astronomers and others have held for some years that a universe as large as ours, and having so many suns, probably does not contain just one unique earth. If there are other earths at appropriate distances from other suns, and if life arose as a natural chemical event, then, it is held, it is probable that there is life elsewhere. Project Ozma, named for the Wizard of Oz, was a search, which has since been dropped, for intelligent signals from some other world. The investigation centered on two strongly-active radio sources. Investigators tried to find "sense" in the signals that might have been expected if intelligent beings were present. The project has been abandoned, at present, without the detection of signs of intelligence at work far out in space.

2,000 Radio Sources

There are some 2,000 radio sources now known to radioastronomy. Most of them are outside our Milky Way galaxy and only ten to fifteen radio sources at present have been tied to visual objects so that their distance can be evaluated.

Radio and radar telescopy has greatly added to the information of science about objects in our Solar System during recent months. A radar signal has been bounced off Venus giving the most accurate measurement of the distance to that planet that is yet available.

Yale Group

A Yale University group has recently completed a non-steerable radio antennae array which is about half a mile long. A constant vigil on the radio "sounds" from Jupiter — which are actually enormous outbursts packing the wallop of a small atomic bomb — will be maintained. Already records of the noise from Jupiter made by Yale and many other observatories have pinpointed the planet's period of rotation at nine hours, fifty-five minutes and 29.37 seconds. This result, it is believed, is a thousand times more accurate than calculations of the period of rotation of the planet by optical means.

With the construction of the new giant steerable radio-telescope in West Virginia, and the construction of other radioastronomical instruments in many nations, the new science appears to be a comer.

'Light-Beam' Radar Could Map Small Moon Area From Earth

A "light-beam" radar for many scientific explorations, including mapping the moon more accurately than before, has recently been developed.

Eventually an optical radar operating from Earth could spotlight its beam on a moon area only 10 miles in diameter, Dr. George F. Smith, of Hughes Aircraft Company research laboratories, Malibu, Calif., disclosed at an IRE convention in New York.

"This would make possible sharper pictures (even determining more accurately the height of the moon mountains) than those now made by 'illuminating' the moon with radio or microwave signals from ordinary radar which disperses its beams over such large areas that their intensity is dissipated," he declared.

"The compact, lightweight device has exceptionally high angular resolution and, although it is still in early stages of development, already produces a narrow beam 100 times as narrow as the signal from conventional radar," he added.

"In outer space there are, of course, no clouds or atmosphere to absorb the radar's optical beam," Dr. Smith explained. "But even on the ground in the Earth's atmosphere, the new device can distinguish between two adjacent 10-foot-wide objects five miles away."

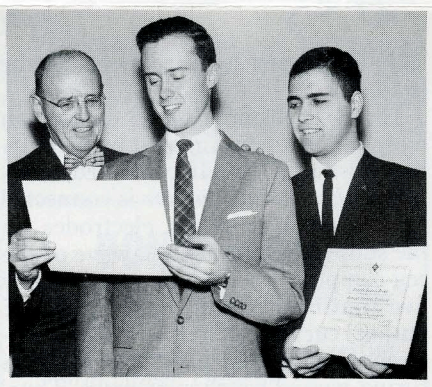
The key part of the radar is its light source, a laser (for Light Amplification by Stimulated Emission of Radiation), which produces an intense burst of pure red light in an extremely narrow beam.

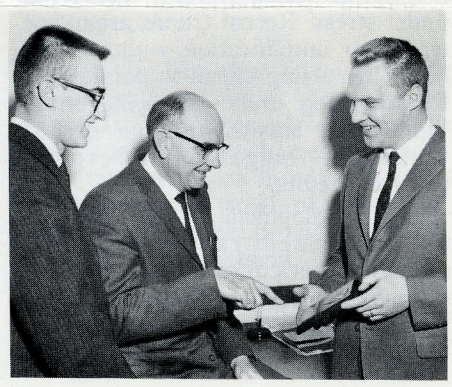
"For radar operation, a short pulse of laser light strikes a target. The light reflects back from the target into a telescope, where it is detected by a light-sensitive phototube. The time needed for the light burst to make the round trip provides an accurate measurement of the distance of the target.

"The radar can operate in scattered sunlight or other illumination because a red filter in the receiver blocks out all kinds of light except the precise color of the laser beam. This permits the device to function better in daylight than previous optical radars, which use white light."

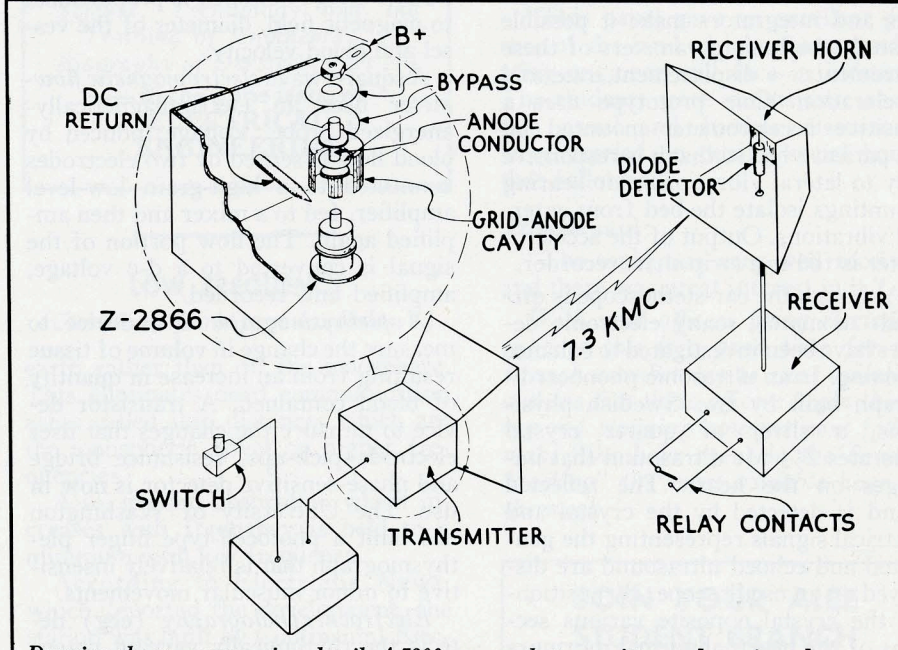
Dr. Smith said that he expects improvements in the radar's design and further development of the laser to enable the experimental system to operate at much greater distances than those achieved up to now — two miles in full sunlight and 7 miles at night.

STUDENTS AT TWO EASTERN COLLEGES WIN AIEE AWARDS





AWARD WINNERS: In photo at left, winners of Northeastern University's student electrical engineering paper-writing contest are shown receiving certificates of merit from AIEE district vice-president Frederic S. Bacon, Jr. (left). Winners are Lennart E. Long, first place (center), and runner-up Robert M. Glorioso. In photo at right, Stephen Bohrer (right), vice chairman of the AIEE Student Branch at the University of Buffalo, shows award he received from Erie County Chapter of the New York Society of Professional Engineers to Professor F. P. Fischer (center), AIEE Student Branch Counselor, and to Thomas Schober, Chairman of the AIEE Student Branch.



Drawing shows construction detail of 7300-megacycle transmitter and receiver demonstrated by General Electric recently. Miniature transmitter uses a tiny metal-ceramic receiving tube.

MEDICAL ELECTRONICS

DIGEST

(Digested from Electronics Magazine, January, 1961)

Electronics is taking more and more of a role in the medical field. The medical profession has benefited tremendously from the application of electronic techniques to the problems of medicine in recent years, and there is reason to think that in another twenty years physicians will be even more heavily dependent on electronic equipment for routine office, hospital and clinical use. This time table may be stepped up by the increasing interest in the field by the military — especially with regard to manned space vehicles.

Electronics can lend a hand to the physician in making a diagnosis by providing more accurate data. A quick review of measurement techniques and instrumentation used in diagnosis will give an idea of the scope of electronics in the medical diagnosis. In a recent issue of the magazine, Electronics, there was a full discussion of the subject. The following is a digest of the article, covering the main uses of electronics in the medical field.

Electrocardiographs (ecg) detect and measure electrical potentials generated during contraction and relaxation of the heart muscle, and make a paper record of the events in time sequence. Amplitudes and waveforms have been correlated with heart action so that abnormalities show up as variants from empirically established norms. Instrumenting ambulatory patients is important in discovering abnormalities which are only discovered under stress. Recent trends are to use transistor amplification without seriously increasing signal-to-noise ratio. Portable ecg units are being made lighter and smaller through use of transistors, ruggedized tubes and printed circuits.

One development is a three-ounce transistorized transmitter worn around the neck or carried in the pocket. Signals picked up from body electrodes are broadcast to a remote f-m tuner that drives a conventional ecg.

Body Movements

A *ballistocardiograph* (bcg) detects and measures the small movements produced in the human body under influence of displacements of heart and blood occurring in connection with cardiac activity. Different types of transducers and electronic differentiators and integrators make it possible to study the basic parameters of these movements — displacement, rate and acceleration. One prototype uses a sensitive accelerometer mounted on the patient's bed so that it is responsive only to lateral vibrations. Air bearing mountings isolate the bed from external vibrations. Output of the accelerometer is fed to a strip chart recorder.

Although the ear-stethoscope is difficult to match, many electronic devices have been investigated to enhance listening. In an ultrasonic phonocardiograph built by two Swedish physicians, a sliver of quartz crystal generates 2½ Mc ultrasound that impinges on the heart. The reflected sound is detected by the crystal and electrical signals representing the generated and echoed ultrasound are displayed on an oscilloscope. By positioning the crystal opposite various sections of the heart, abnormal murmurs are registered with a sensitivity previously obtainable only surgically.

One invention circumvents the distortion introduced by body tissue lying between the heart and the outside, or by breathing sounds. A tiny microphone is mounted in a catheter that permits pickup of sounds from within the heart. Heart pulsations are picked up by a window diaphragm whose vibrations activate the pointer, causing the ceramic element to vibrate. This produces an electrical impulse that is fed into a cathode follower and amplifier for showing on an oscilloscope.

Brain Pulse Changes

A new area of *phonography* consists of studying the sounds connected with pulse changes in the brain. Topical diagnosis of brain injuries is possible by placing a microphone on the head.

Energy consumption of the human body can be approximated by measuring pulse rate. A self-contained, cumulative *heart beat counter* is connected by a flexible cable to electrodes on the subject's chest. The R-wave of the ecg complex is selectively amplified by five transistor stages. Every pulse of output current activates an electromechanical arrangement that drives a spring-wound watch movement. Thus, each R-wave is recorded as 1/5 second.

Probably the most widely-used electronic technique in measuring the blood flow rate is to measure the voltage developed by the velocity of the blood (considered a conductor) when an exposed vessel is in a magnetic field. Voltage obtained is proportional to magnetic field, diameter of the vessel and blood velocity.

A square-wave *electromagnetic flowmeter* uses an electromagnetically-energized probe. Voltage induced by blood flow is sensed by two electrodes connected to a high-grain low-level amplifier, fed to a mixer and then amplified again. The flow portion of the signal is converted to a d-c voltage, amplified and recorded.

A plethysmograph is a device to measure the change in volume of tissue resulting from an increase in quantity of blood contained. A transistor device to measure the changes that uses electrode pick-ups, resistance bridge and phase-sensitive detector is now in use. The University of Washington has built a photocell-type finger plethysmograph that is relatively insensitive to minor muscular movements.

Electroencephalography (eeg) detects the rhythmically varying potentials produced by the brain using 15 to 24 pairs of electrodes placed at various positions in the scalp. After amplification, the signals from pairs of electrodes are recorded. Thus, it is possible to diagnose a variety of neurological disorders, and to measure the state of consciousness.

Voltage picked up by electrodes directly on or within the brain are 10 to 100 times greater than those taken at the scalp surface and the responses are much faster. In recent years, microelectrodes capable of detecting the activity of a single nerve cell have been developed.

Skin Response

Galvanic skin response and skin resistance are used as reliable indexes of a number of psychological states. A portable *transistorized tissue resistance monitoring instrument* uses a low frequency, alternating sensing current. Amplitude of the current is a direct measure of the tissue resistance permitting the simultaneous monitoring of the tissue potential. One skin resistance measuring instrument uses a specially designed nonpolarized zinc disk and plastic holder combination which allows placement on almost any part of the body.

In *temperature measurement,* both thermocouples and thermistors have proven satisfactory as temperature sensors. Recent research indicates that semi-conducting diamonds whose electrical resistance varies with slight changes in temperature, might make excellent sensing elements.

Respiratory measurements are useful in determining the amount of oxygen consumed by an individual, and changes in rate and depth of respiration. Strain gage transducers mounted on an elastic band have been constructed for measuring chest expansion. Recordings made from the strain gage signals give an approximation of respiratory volume and rate.

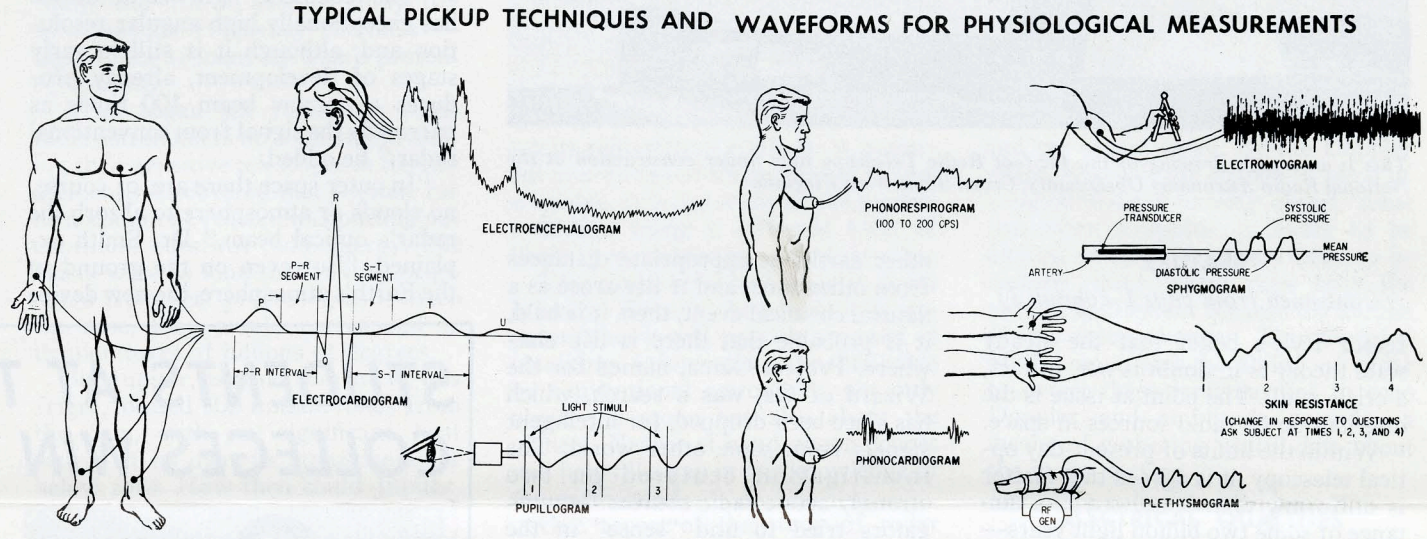
Eye Measurements

In *eye measurements,* pupillary reactions are indicators of automatic nervous activity. Electrical response of the human retina to light stimulation can be measured on an electroretinagraph (erg). Recently, a technique for measuring eyeflicker caused by light stimuli was devised by using a contact lens electrode. The response signal is fed to a resonance amplifier to preserve a high signal-to-noise radio. Amplitude is read off a dial of a resonance meter tuned to the rate of stimulation.

In *gastrointestinal measurements,* endoradiosondes (radio pills) detect and transmit physiological data from the gastrointestinal tract. A number of radio pills have been developed in recent years. One pressure sensitive pill uses an internal oscillator frequency modulated by the movement of a diaphragm-mounted ferrite disk that is part of a magnetic circuit containing the tuning inductance.

Satisfactory operation of radio pills for wide-range pressure fluctuations has been achieved at the U. of California.

TYPICAL PICKUP TECHNIQUES AND WAVEFORMS FOR PHYSIOLOGICAL MEASUREMENTS



The newest, smallest and most accurate device for diagnosing human heart trouble is this tiny electronic micromanometer and intercardiac microphone, developed by bioelectronic scientists abroad and by International Rectifier Corporation, El Segundo, Calif. It is inserted into the heart through the arteries and reports both heart murmurs and pressure from inside the heart.

ELECTRICITY USED AS ANESTHETIC

Electricity was used as an anesthetic in a recent experiment at the University of Mississippi Medical Center. An electric current was used to produce surgical anesthesia in two patients, with excellent results.

Electronarcosis, as it is called, is aimed directly at the brain. In the experiment, electrodes were applied to each temple of the patient, and the current was turned on and rapidly increased to 50 or 55 milliamperes. At this level, the patient went to sleep and remained anesthetized for thirty minutes. Sixty seconds after the current was switched off, the patients opened their eyes. They felt no pain and remembered nothing of the operation. There were no after-symptoms such as nausea and drowsiness, commonly associated with other types of anesthetics.

HIGH-SPEED CAMERA HAS BEEN DEVELOPED

A new ultra-high-speed camera is capable of shutter speeds up to 2½ billionths of a second.

The unusual speed of the camera, which will take 20 million frames a second, is attained by a combination of image-converter techniques and new concepts of fast pulse circuitry developed at Space Technology Laboratories. Use of a new RCA image converter developmental tube permits electronic shuttering and light amplification, and allows movement of image rather than the film, as on a cathode ray oscilloscope. Less than ten inches long, the tube serves as the electronic shutter of the device. It permits extremely short exposure times when used as a high speed light shutter. Deflection plates permit a series of time sequential frames or single exposure.

The camera has been used to photograph a transverse pinch in deuterium gas. Also, several pictures have been made of a toroidal plasmoid compressed by a strong magnetic field.

The new research tool is expected to be extremely valuable in the field of plasma physics, including propulsion systems for space vehicles.

METAL-CERAMIC CELL PRODUCES ELECTRICITY

A metal-ceramic combination that produces electricity when heated is being investigated to determine the basic principles involved, and to develop materials with increased electrical output.

The combination, called an Austin cell in honor of its inventor, B. O. Austin of Westinghouse, consists of a piece of iron coated with a porcelain enamel which in turn is coated with a thin layer of silver. Iron acts as the negative pole, silver as the positive.

At temperatures of 400° to 1200°F, the cell produces up to 16 milliwatts of power per square inch of silvered surface initially. It continues to produce approximately half this output for two to three hours.

The cells are being investigated at Battelle Memorial Institute, in cooperation with Westinghouse. In a little more than a year of work on experimental cells, the research program has increased the output from two-tenths of a milliwatt output per square inch, the original observation, to 16 milliwatts per square inch. The useful life of the cell has been prolonged from a few minutes to several hours.

The device appears promising for missile and space uses, since it operates at temperatures which cause conventional power sources to fail.

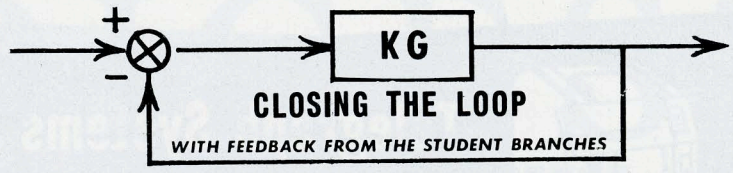
Machine Engraves Plates From Electronic Impulses

A machine which engraves plates for rotary printing presses and textile pattern-printing machines from electronic impulses has been developed recently in Germany.

The machine accepts impulses from scanned photographs, recorded music and speech, and reproduces them as a design on the cylindrical plate. Color gradations are attained with one plate which could formerly be achieved only with two or more.

The machine consists of a central section housing the motor, on one side of which is a photo-electric scanning head and on the other a diamond en-

(Continued on page 8, column 2)



By JOHN MORRISON — STUDENT COORDINATOR

The Best Hour Of The Week

In your opinion, what is the most profitable hour you spend at school each week?

Is it the class in Differential Equations? Physics? Circuit Theory? Servomechanisms?

I don't know how the Student Branch Meeting rates with you, but it could rank high — since most Branches set themselves the task of relating their members realistically to the careers they will pursue after graduation.

Industrial speakers, contacts and panels are frequently used effectively to do this. The potential for valuable personal information is there, and good questions from Branch members can help get it across.

Some cases where there has been exceptional interest in a Branch program have come to my attention.

For example, the **Valparaiso** Branch invited a Sales Engineer from Alcoa to speak. The Branch prepared a panel to ask questions of the speaker. The program was effective.

". . . the most interesting, well-delivered, and informative talk ever given before the Branch" at **University of Maryland** was on "Digital Computers — Retrospect and Prospect" by a speaker from Westinghouse.

"Trends in Advanced Technology as Related to Space Flight" was a topic "thoroughly enjoyed" at **University of Buffalo.** The speaker was from General Electric.

The **University of Utah** Branch ran a series of 5 programs during National Engineering Week for 250 or more students. The most effective program was "The Expert Witness" by a Professor from the Law Department.

"Engineer and the Union" was a topic that provoked a lot of interest at the **University of Detroit**. The speaker was from Micromatic Hone Corporation.

A Fulbright Scholar at **University of Southern California** illuminated electrical engineering education in the Federal Republic of Germany in a talk to the Branch entitled "Das Ohm, das Volt, und ein Glas Bier".

Even such devices as transformers can intrigue a Branch if the speaker has the kind of knack a TVA engineer displayed before the Branch at **Tennessee Tech.** His topic — "A Device for Use in Testing Large Power Transformers."

Branch members at **Johns Hopkins** got indoctrinated in "Target Tracking with Microwave Radar" during an "excellent and easily understood" program by an engineer from Wheeler Laboratories.

A talk and slides of "extreme interest" on "Global Communications via Artificial Satellites" was given to a **Brooklyn Poly** meeting by a Bell Labs speaker.

Over 35 Branches have tried out the "After Graduation, What?" panel idea AIEE has been encouraging. In this program, Branch members submit "job" questions in advance to be answered by a panel of practising engineers, the panel provided through the local AIEE Section.

The response has been very good. For instance, from **Arizona State,** the report was:

"Extreme interest was shown by all students, and due to the fine response which greeted this initial discussion, a motion has been adopted to make a panel discussion of this type an annual event."

Lafayette College reported:

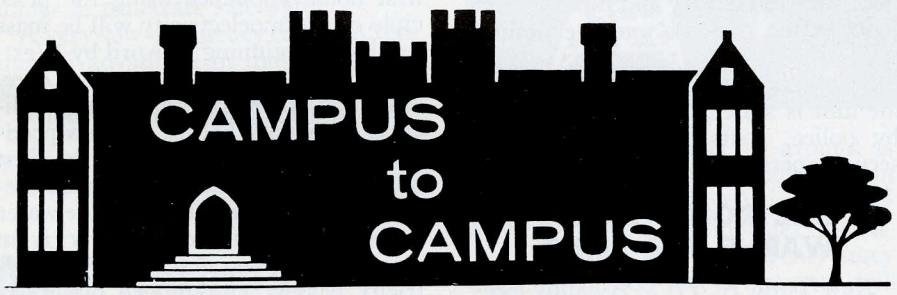
"This panel gave an excellent picture of the kind of jobs that a graduating engineer will face in industry. The students were enthusiastic about this panel and further discussions were carried on during social hours that followed."

Tulane said:

"The topic was very well received and there was great interest in it."

With new officers being elected, I suppose this is a good time for the Branch membership to start agitating and see that these officers begin thinking and planning now for next fall to make "the hour spent in the Branch Meeting" the most valuable hour of the week.

JOIN YOUR AIEE STUDENT BRANCH



The Midwest Program on Airborne Television Instruction, conducted at **Purdue University,** Lafayette, Ind., has selected 31 elementary and secondary schools to demonstrate its educational offerings. The demonstration schools are situated in Illinois, Indiana, Kentucky, Ohio, Michigan and Wisconsin . . . Corn pads, an FM set, and a special electronic belt have enabled **University of Michigan,** Ann Arbor, researchers to record the heart beat of athletes playing tennis, squash, volleyball, and a wide variety of sports for the first time.

The **University of Dayton,** Ohio, will inaugurate a graduate program in engineering in September. Courses in the program will lead to the degree of Master of Engineering . . . A summer course on Materials Science will be held in June at **Massachusetts Institute of Technology,** Cambridge, Mass., under the joint direction of the Departments of Electrical Engineering and Metallurgy.

The **University of Pennsylvania,** Philadelphia, Pa., has been presented by the Western Union Company with two modern facsimile transceivers for use of students in the Moore School of Electrical Engineering. The machines are actual production models of equipment now in use by the donors . . . A new systems concept of engineering education at **Michigan State University,** East Lansing, improves communications among the traditional engineering disciples by providing a common mathematical language. With the new concept, students no longer need to study mechanical, electrical and hydraulic networks as separate subjects, but can cover all three areas in one course.

Loyola College, Baltimore, Md., has broken ground recently for a new Engineering-Physics Building, expected to be completed by the summer of 1962 . . . A six-week summer institute will be sponsored by **Iowa State University,** Ames, Iowa, for teachers of engineering on the properties of engineering materials . . . The Atomic Energy Commission has awarded $93,000 to **Boston College,** Chestnut Hill, Mass., for nuclear research.

DON'T MISS:

Technical Manpower for the Next 100 Years
Our Scientific and Engineering Manpower Outlook
Biography of Hans Christian Oersted (Part I)
— in the May issue of ELECTRICAL ENGINEERING

A.I.E.E. and Application Engineering
Science, Technology and the Training of Engineers
Biography of Oersted (Part II)
— in the June issue of ELECTRICAL ENGINEERING

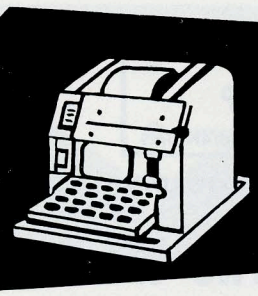
LOW FREQUENCY

(Continued from page 1, column 1)

earth rather than off the ionosphere. This eliminates dead communication areas called skip distances which are the ionospheric effect on higher frequencies.

Also, ground absorption which increases with frequency is held to a minimum with low frequency.

According to Electronic News, which reported the development, the station was built by Continental Electronics Manufacturing Company.



Telegraph Systems

H. F. Caley, New York, N. Y.

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

The telegraph industry, which pioneered in such varied developments as frequency-modulated carrier systems, radio beam transmission, ocean cables, submerged repeaters for ocean cables, multiplex, and electronic switching systems, has experienced a rather remarkable growth in recent years because of the increasing need for rapid, accurate record communications by industry and government. The public message service furnished by the telegraph industry is well known, but the many extensive private telegraph networks designed, built and maintained for private industry and governmental organizations are not so well known. These systems vary greatly in complexity. Some are simple point-to-point printer circuits, others are comparatively simple electro-mechanical switching systems which are manually operated and used to interconnect a small network of branch offices and factories, while some are very elaborate electronic switching systems which are fully automated and used to interconnect hundreds of individual stations. Such systems are custom designed to meet the unique requirements of each customer.

In addition to the growth of message traffic, the rapidly-increasing use of integrated data processing by large industries has greatly increased the load on these systems. Data has been sent over telegraph systems for many years but the transmission of data between machines without human processing or monitoring is a recent innovation.

The increase in load has accelerated the development of higher-speed input and output equipment and transmission channels while the need for extremely low error rates and the lack of human monitoring of the traffic has resulted in the development of new techniques for detecting and correcting errors introduced in transmission and by equipment.

The increasing demand for automation in traffic routing has already resulted in development of several automatic message switching systems and more automatic systems are now under development. The more modern systems use electronic components to replace larger and more costly electro-mechanical equipment. Recent developments in solid-state devices has given considerable impetus to use of electronic switching systems in telegraphy.

Automatic circuit switching systems, long used for telegraph communications in Europe and for telephone switching in the United States, are being introduced in this country to supplement the many message-switching systems now in use. So far, electronic components have not been used extensively in these circuit switching systems, but there is a definite trend towards all-electronic switching systems, with the latest systems making liberal use of solid-state components.

Rapid growth of record communications has made it necessary to expand the transmission facilities as well as increase their speed to handle the additional load. New radio beam systems are being designed and built, together with improved transistorized carrier systems to permit more efficient use of existing facilities.

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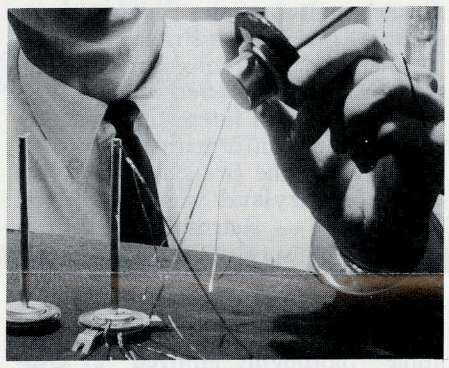


Space ships and satellites will get electric power from a device like this GE 10-watt vapor thermionic converter which can make electricity directly from the sun's heat.

MACHINE

(Continued from page 7, column 2)

graving head. The image to be engraved is placed on a light-weight cardboard cylinder. Light impulses from the scanning head are fed to an amplifier, rectified and passed to a "contrast adjustment" circuit.

Both depth and area of dots are controlled by the light intensity of the original. This gives greater variations than the conventional acid engraving technique. Speed of the machines is from 1400 dots per second (coarse screens) to 2800 dots for finer screens.

The machine was developed by William Staub, Neu Isenburg, Germany (near Frankfort). E. I. du Pont de Nemours & Co., Inc., has ordered the machine for delivery in the U.S.

Solution to crossword puzzle, page 3.

M	A	G	N	E	T	O	M	O	T	I	V	E		
I	T		E		A	S	S	A	I	L		L		
C	O	N	T	R	A	C	T		M		R	E		
R	M		W	E		I		C	E		L	C		
O		S	O		B	L	E	A	C	H		T		
M	E		R	E	A	L		S	O	N	A	R		
I		S	K			O	P	E	N		T	O		
C	H	A	S	S	I	S			S		A	S		
R	I	B		E		C	O	N	T	A	C	T		
O		E	A	T		O	X		A	N	K	A		
F	E	R	N	S		P	I		N			T		
A	V		G		S	E	D	A	T	E		I		
R	E	P	E	L			E	U		A	R	C		
A		I	L	I	A	D		N		R	A			
D	I	P	O	L	E	A	N	T	E	N	N	A		

NEWS CLIPS

BETTER MATH TRAINING IN COLLEGE URGED

Washington, D.C. . . . College mathematics training must be updated to keep abreast of the "explosion" of knowledge in engineering, a group of leading engineers and mathematicians was told here. A rapid change in the mathematical world and its related fields has made this revision necessary, Dr. H. O. Pollak, Bell Telephone Laboratories, said.

New applications of mathematics in engineering are creating new trends in the engineering world, Dr. Pollak said. More emphasis on basic science, installation of complex engineering systems and wider duties of research engineers demand a stronger mathematics background.

PORTABLE X-RAY UNIT DETECTS BOMBS

Baltimore, Md. . . . A portable X-ray inspection unit to detect bombs or booby traps in packages by fluoroscopic and radiographic means has been developed.

The inspection device is designed so that it can be partially dismantled to accommodate packages of unusual size or shape. Ordinarily it handles objects up to 30 inches high and 18 inches wide. Weighing 160 pounds, the unit is made of aluminum. The case includes an X-ray tube, viewing hood, and protective shielding. It operates on 115-volt, alternating current.

Only a few seconds of operation are necessary to identify and film the contents of the package under examination.

Now in production at Westinghouse, the unit is suited to a variety of uses by police, postal, prison and other security personnel.

ELECTRONIC DEVICE WARNS THE BLIND

New York, N. Y. . . . A handy electronic instrument to warn a blind person of obstacles in his way has been developed. The compact, two-pound device, which can be carried by the person, "sees" by sending out nearly invisible light waves up to nine feet away. Any obstacle causes the light to trip a vibrator, warning the blind man.

ELECTRONIC NERVE CELL WILL SIMULATE THOUGHT

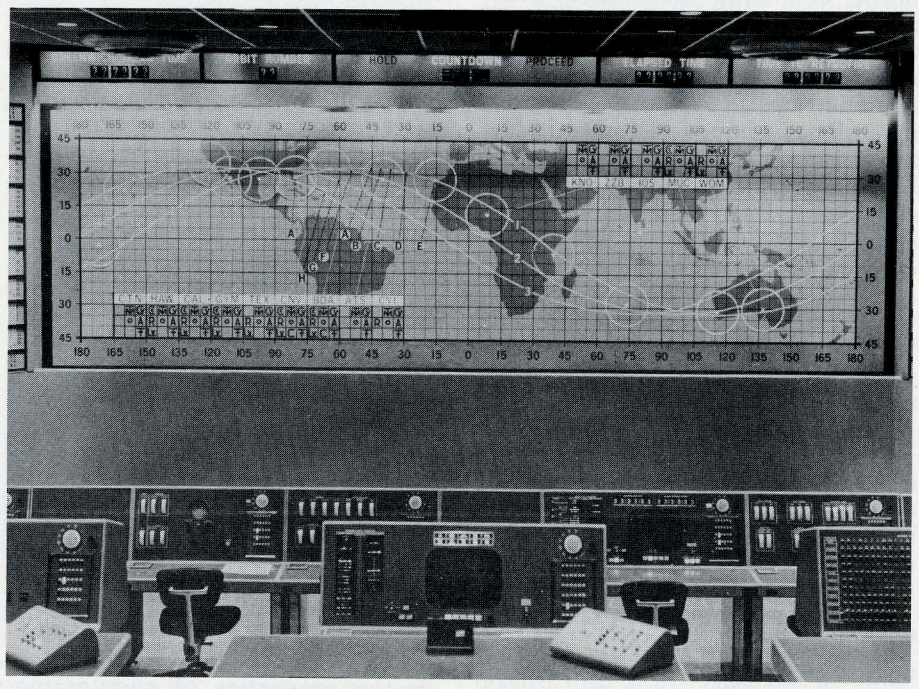
Falls Church, Va. . . . An electronic nerve cell with the power to simulate elementary "thinking" may be the forerunner of thinking machines for unmanned space vehicles and weather predictions. Called Artron (artificial neuron), the cell will "learn," as in animal studies, from reward and punishment signals. It will be built by Melpar, Inc. under contract with the U. S. Air Force.

MOISTURE DETECTOR FOR MISSILE INSTALLATIONS

Fort Belvoir, Va. . . . A moisture detector for missile installations can detect moisture that may cause vital instruments and equipment to break down. The 35-pound "electrolytic hygrometer" absorbs and simultaneously electrolyzes any moisture it spots from an air sample. It was developed by the U. S. Army Engineer Research and Development Lab.

UNIQUE APPLIANCE PRODUCED

Columbus, Ohio . . . The nation's first home appliance using the principle of thermoelectricity will be mass produced beginning in April by Westinghouse Electric Corporation here. Although other prototype home appliances were tried before, the new product, a water cooler, will be the first built on a production line basis. Designed for home or office use, the water cooler is refrigerated directly from electricity with no moving parts. Electricity passes through two dissimilar metals, creating the necessary cooling without the conventional compressor.



DISPLAY FOR A MAN IN ORBIT — This control display system for Project Mercury's Control Center at Cape Canaveral, Fla., is housed in a 50-by-60-foot operations room. Data will flow into the center from the orbital capsule, from 18 world-wide data stations, and high-speed computers. The world map on the room's front wall displays the capsule's path in orbit and the locations of the remote tracking stations. This display system was built by General Dynamics/Electronics.