GENERAL SCIENCE

1964 Science Review

Detailed highlights of achievements of the year reported and compiled by Science Service as a record of an eventful period of science, research and technology.

By SCIENCE SERVICE STAFF

This summary is limited to highlights, and credit to investigators and institutions is necessarily omitted. If you want more information about any item in the summary, send 25¢ to help cover answering costs for each item upon which more information is requested. Address Science Service, Inc., 1719 N St., N.W., Washington, D. C. 20036.

ARCHAEOLOGY

Possibly the oldest known habitation of man in Europe, a partly subterranean camp of rhinoceros hunters in Northern Greece that dates back 40,000 or 50,000 years, was unearthed by British archaeologists.

What may be the most extensive archaeological effort of all time to salvage ancient sites was undertaken along rivers in North America, Egypt and elsewhere before they are drowned by dams built for flood control and hydroelectric power.

Three badly corroded pins, believed made of copper and perhaps the first ever fashioned, were found in an excavation near the headwaters of the Tigris River.

San Salvador Island in the Bahamian Archipelago was reported to be the first land sighted by Christopher Columbus.

A Greek settlement 25,000 years old, believed to be either the legendary Sybaris or its seaport, that man may never see because the ruins lie 15 feet below ground water level was discovered using a rubidium magnetometer.

A large burial tomb, erected in the seventh century B.C. for King Gyges, was uncovered about ten miles from Sardis in Turkey.

A tiny stone wheel, lost in the Newfoundland wilds for centuries, was identified as part of a spinning device, possibly the first known Viking household article unearthed on this continent.

Crude man-made farming tools that are 9,000 years old were uncovered in Afghanistan, and found similar to such tools previously discovered in Turkey, Jordan, Greece, Iraq and Iran.

Opposite St. Louis, Mo., at "Cahokia," site of a thriving Indian civilization about 1,000 A.D., excavators uncovered four huge circles of spaced wooden posts that may prove to be an ancient solar calendar.

An ancient metal smelting furnace, dating back to the 11th or 10th century B.C., was found in the Arabah depression of Southern Israel, indicating that smelting processes used 30 centuries ago were more sophisticated than previously imagined.

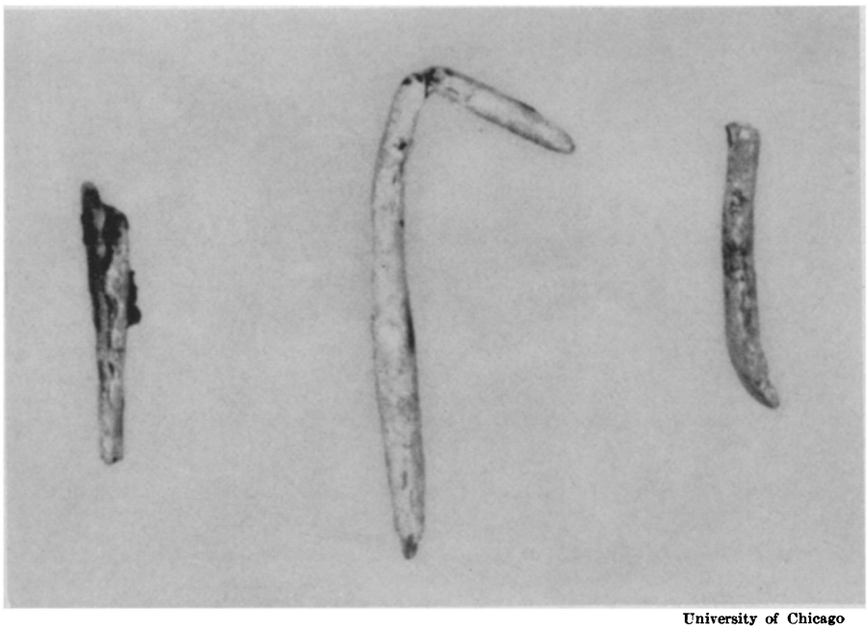
A series of recent carbon-14 datings of brick and pottery found in river valleys north of Rome indicated that the "fall" of the Roman Empire might have been due to slow economic death, caused by increasing deposits in the river beds that made sailing ships to inland ports in the area difficult.

A medieval Islamic residence and part of the defense battlements of ancient Hebron during the reign of King David were unearthed in Jordan.

Carbon-14 dating of 50 Soviet sites, ranging from Paleolithic to historic times, resulted in revision of racial and cultural hypotheses.

Rock drawings from various periods were found throughout Soviet Armenia.

A new species of dinosaur was uncovered in Wyoming this past summer, unique among flesh-eating dinosaurs for two reasons: first, its hand claws are larger than its foot claws and second, it has at least four claws on each "hand" instead of the usual three.



University of Chicago

EARLIEST METAL TOOLS—These three metal "pins" about 9,000 years old and now oxidized are believed to have been made of copper. They are the earliest known instance in which man used metal, rather than wood or stone, to make tools. These objects, slightly under one inch in size, were found by an archaeological expedition at a prehistoric village at Cayonu in Turkey. Robert J. Braidwood, professor in the Oriental Institute of the University of Chicago, was one of the leaders of the expedition.

ASTRONOMY

Gravitational collapse was suggested as the fuel for the strange heavenly objects, named quasars in a contraction of quasi-stellar sources, that are the brightest, most violent, heaviest and most puzzling sources of light and radio waves yet discovered; they may also be the most distant.

Ten X-ray sources have so far been discovered in the sky, of which the one in Scorpius is the strongest, as was discovered by a rocket flight; another rocket flight showed that the Crab Nebula, the visible remnants of a known supernova in 1954, was not a neutron star as had been suggested to account for X-rays detected from that region.

A surprisingly strong source of combined oxygen and hydrogen atoms, called hydroxyl molecules, found near the center of the Milky Way galaxy in the constellation Sagittarius, was considered an outstanding discovery because the source is 100 times stronger than expected.

A panel of the National Academy of Sciences recommended that the U.S. spend $224 million during the next ten years to double the country's ground-based astronomical facilities in order to continue probing the structure and history of the universe; plans for future orbiting astronomical observatories were also endorsed.

Radio astronomers in North and South America took full advantage of the allocation by the Federal Communications Commission and the International Telecommunications Union reserving exclusively until Jan. 1, 1974 the frequencies from 608 megacycles to 614 Mc, television channel 37, for listening to radio waves from space.

An image tube, a simple device to photograph stars electronically, that makes any telescope the equal of one three times its size will be available to 20 observatories around the world, it was announced.

The polarity for the vast magnetic field of the Milky Way galaxy was determined for the first time, showing that some segments have a polarity the reverse of that of other segments in a pattern varying systematically with galactic longitude.

The rare form of carbon-13 was detected for the first time in the light of a comet, and its abundance indicated that comets were born near the earth and are not visitors from interstellar space that have been captured by the sun.

New calculations extending Pluto's orbit back two million years showed that this planet's origin was not as a satellite moon that escaped from Neptune or an object that became a planet circling the sun after being captured when it strayed into the solar system from interstellar space.

Water vapor was detected in the atmosphere of cool, red giant stars, and its effect measured for the first time.

A 20,000-degree pocket of "cool" gas in the solar corona was discovered.

The exploding galaxy known as M-82 was found to be showering the earth with neutrinos having the unexpected property of reacting with matter ten billion times more frequently than would have been predicted.

The large-scale magnetic field of the galaxy M-82 was observed for the first time and found to be about 63,000 times stronger than the earth's magnetic field.

Plans were announced to triple the focal length of the world's largest telescope, the 200-inch Hale telescope atop Mt. Palomar, thereby increasing its "seeing" power at least 50% so that it will be able to photograph objects of 24th magnitude.

Discovery of a region of the sky in Cygnus that contains an unusual number of separate discrete radio sources of various sizes was reported.

Plans were made to detect solar neutrinos in a tank containing 100,000 gallons of pure perchlorethylene placed 4,500 feet deep in a mine.

The atmosphere on Mars was reported to be as thin as earth's air 15 miles above the surface, or about a third as dense as previously believed, requiring scientists to revise their designs of capsules that could land on Mars.

A peculiar change in the polarization of sunlight from the Martian surface was reported to mean that life in the form of microorganisms living on top of limonite may exist on Mars; the wave of darkening that moves across the dark areas was suggested to result from the growth of microorganisms as they receive vital water vapor when the Martian polar caps shrink during summer.

Venus rotates on its axis in a retrograde direction once every 248 to 258 earth days, astronomers found in radio astronomy measurements that achieved an accuracy five times higher than previously possible.

Direct evidence was reported of water vapor on Venus, raising the possibility that some form of life may exist on that planet; however, contrary evidence was reported in a calculation, based on the high temperature of 800 degrees Fahrenheit measured by the Mariner II space probe, that Venus has neither life forms of the usual hydrogen, carbon and nitrogen compounds nor hydrocarbons.

The rotation rate of Jupiter was reported to have suddenly slowed by 1.3 seconds in 1961, a change detected both in four sources of radio waves from Jupiter and in the Great Red Spot.

The magnetic poles of Jupiter were found to be far to one side of the planet's axis of rotation, some 30,000 miles from Jupiter's center.

How certain giant stars called Cepheids or RR Lyrae stars pulsate was determined by calculating mathematical models of them in a computer.

Discovery of a white dwarf star with a diameter of possibly less than 1,000 miles, believed to be the smallest stellar object ever sighted, was reported.

An infrared detector fitted to the 200-inch telescope showed that the apparent temperature of Jupiter's atmosphere increases more than a hundred degrees in areas darkened by shadow of one of its moons.

The asteroid known as 1948 OA made an unusually close approach on Aug. 10 when it passed within 11.7 million miles of the earth, and on Aug. 12 Comet Ikeya came within 19 million miles of the earth.

The sun's system of nine planets was reported to contain some two million comets, of which seven new ones were spotted during 1964.

Due perhaps to volcanic dust high in earth's atmosphere, the total eclipse of the moon on Dec. 30, 1963, was so dark that the moon could not be seen during totality, and the one on June 24, 1964, was much darker than usual.

BEHAVIORAL SCIENCES

Race and its implications were discussed from a biological point of view by experts from around the world at a meeting in Moscow that was sponsored by UNESCO.

Psychologists attempting to communicate language through the skin by vibrations met with some success.

"Finger sight," the ability some persons have of differentiating between colors wtih their fingers, was shown to be experimentally valid in studies.

A chemical found naturally in mice was reported to produce symptoms of mental illness when injected into them.

Hypnosis helps hay fever and asthma sufferers both physically and psychologically, tests showed.

Noises used by monkeys to communicate information were catalogued by a Japanese scientist.

So-called "paradoxical" sleep, the kind producing dreams, may not be sleep at all but a state of the brain that has not been properly identified, studies of patterns of electrical activity showed.

Home movies taken of older persons when they were younger can be used in psychoanalysis, it was reported.

The drug psilocybin, known to give weird visions, was found to distort speech as well.

Monkeys deprived of their mothers from birth were found to have less interest in looking at various objects than monkeys normally reared.

Newspaper editors and writers have the highest anxiety level of any professional persons in the U.S., a study indicated.

Negro college students in the North show no more bias for or against their race than Negro students in the South, tests indicated.

The "bold new approach" formulated by the late President Kennedy was credited for the increasingly healthy attitude toward mental illness.

Negroes are much more inclined to oppose interracial marriages than most white persons think, a study showed.

When a Negro student enters a desegregated classroom, he may fail to make the grade because of feelings of inferiority, isolation and rejection, rather than a lack of intelligence, it was reported.

When men who disliked one another were thrown together on mock space missions for six weeks, it was found that they generally supressed their feelings to concentrate on their jobs.

Monkeys were found to need play in their youth to develop into physically and socially well adjusted adults.

Crowded living conditions among the impoverished rather than civil rights legislation was blamed for the Harlem and Rochester Negro riots.

Pep pills, or amphetamines, once believed to improve a person's performance on various mental and physical tasks, were found to greatly impair judgment.

A large part of the public still thinks the alcoholic is morally weak rather than sick, a survey revealed.

Most troubled families have adopted a set of rules that prohibit discussion in areas that threaten their ease or self-esteem, a study showed.

Indignities suffered by the ego are important factors in the distress felt by oldsters, it was reported.

BIOLOGICAL SCIENCES

A vast supply of food for marine life in the oceans was discovered in tiny bits of brown, shapeless matter created from molecules of dissolved substances on air bubbles.

Studies of the structure and function of the protein cytochrome *c* from 13 species ranging from yeast to man indicated that life on earth may have originated as the result of a single occurrence, since the 13 have structures that are now more than 50% identical.

Short, biologically active chains of deoxyribonucleic, or DNA, with known sequences of bases were synthesized, a major step toward solving the so-called genetic code.

A single cell can now be dissected and studied in detail by a new French process that combines

U.S. Fish and Wildlife Service

WHOPPING WHOOPERS—Though this whooping crane coming in for a landing is large, it is still only a juvenile. The four birds shown are among only 42 wild members of this species still alive. They are spending the winter in the Aransas National Wildlife Refuge in Texas.

light microscopy, electron microscopy, time-lapse cinematography, closed-circuit television, special chemical stains, ultraviolet radiation and laser beams.

Mice share 20% to 25% of their hereditary characteristics with human beings, biologists found by matching pieces of key hereditary molecules of DNA.

The fly has a brain, a zoologist reported, contradicting the popular notion that there is a fundamental distinction between the higher animal that thinks and a lower animal such as an insect.

Studies of a vital protein in a mutant strain of bacteria supplied evidence that scientists have been right in their interpretation of the "genetic code," nature's system for transmitting characteristics from one generation to another.

Man's battle against destructive insects continued on many fronts in an effort to find new methods of control other than chemical insecticides, including biological warfare pitting bacteria, fungi, nematodes, rickettsia and protozoa against the insects; improvements in sterilization of males to mate with females so no offspring are produced; flashes of green light to upset the life pattern of insects; mechanical sounds like those made by bats to make the insects scatter, and suffocation by withdrawing all air from special grain storehouses.

For the first time, photographs of a living microscopic marine animal, *Noctiluca miliaris,* were made by means of the light the creature itself emitted.

Bats were found to be more sensitive to DDT than any other mammal.

Exposure to cosmic radiation about 20 miles above the earth reduced the hatching of fruit flies.

The transmission of a rickettsial disease by an internal parasite was proved by studies of salmon poisoning in dogs.

Surgical removal of a bursa gland prevented one form of a cancer-like disease in chickens.

Scientists studying the fate of pesticides in soil found that a fungus universally present in soils can break down a herbicide into non-toxic products.

The first tiny pulsation of a baby bird's heart was recorded for the first time, using a sensitive instrument originally designed to record microscopic meteorites striking spacecraft and satellites.

The sea urchin has a heart, zoologists proved after 150 years of study—a tiny pulsating organ that appears to pump colorless "blood" through the animal's body.

A new form of vitamin K, essential for blood clotting, was found in the chlorophyll cells of spinach.

The human eyes can detect different colors by the use of tiny cells conducting electricity, instead of by chemical reactions, it was suggested.

A new "Q-form" of microbe, recently isolated from the soil, was found to be ten to a hundred times more abundant than any other living creature known.

Cellulose was synthesized for the first time.

Biologists in Antarctica recorded the deepest dive by a mammal—the Weddell seal dove more than 1,000 feet below the ocean surface.

Polarized light was used in a new way to study a microscopic cellular structure called the nucleolus.

A colorless thread-like microbe, *Leucothrix mucor,* was observed to tie itself in knots when its environment became too crowded.

Biochemists found that citric acid can regulate ceruloplasmin, an essential body enzyme.

Twelve young men lived for 50 days on a strict diet of only wheat foods.

Tiny receptors in human eyes were found to be sensitive to only the three colors, blue, red and green.

Living organisms such as algae, fungi and bacteria were found able to withstand severe extremes of high pressure, salt concentrations and acidity, but showed no evidence of growth at temperatures above 163.4 degrees Fahrenheit.

Millions of tons of fish can be suddenly killed by the lack of dissolved oxygen in water caused by movements of winds and ocean currents.

The tiny flock of nearly extinct whooping cranes increased to the largest number in 25 years; 42 wild birds reached their winter home in the Aransas National Wildlife Refuge in Texas.

Two new bacteria strains were found to decompose certain detergent chemicals, source of much contamination in today's polluted waters.

Juice from turnip greens was found to preserve meat flavors by slowing normal breakdown of fats.

The camel can "store" water for long periods of time due to the composition of its blood and the special nature of its body-temperature regulation mechanisms, a study showed.

Several advances in preservation of foodstuffs were reported, including a process in which carrots, apples and other foods are exploded from a special gun and isolation of a natural food preservative from oats that may slow down the process of spoilage in breakfast cereals, canned foods, oils, margarines and shortenings.

Laboratories established to preserve seafood by radiation in low doses were dedicated by the Atomic Energy Commission.

In renewed efforts to increase plant crops, scientists successfully used salty or brackish water to irrigate plants such as berries, vegetables and flowers.

Experiments on taste revealed that cold and hot water can affect certain taste experiences of the basic bitter, sweet, sour and salty sensations.

A new simple routine test for dog distemper was perfected.

A new genus of an extinct bird, part duck and part goose, which lived about a million years ago, was discovered from fossil remains in California.

Discovery of 7,000-year-old cotton boll fragments proved that cotton grew naturally on American soil long before man could have transported it.

U.S. technicians added underground water pumped from wells to the Colorado River in an effort to lessen the salt concentration as the river empties into Mexico.

Israel neared completion of its 150-mile pipeline to conduct fresh water from the Sea of Galilee to irrigate the arid Negev desert.

A water desalting plant was dismantled at Point Loma, San Diego, freighted through the Panama Canal and reestablished in Guantanamo Bay, Cuba, when the Cuban Government shut off the fresh water supply from the U.S. Naval Base.

Fierce ferrets were made gentle on an ample special diet of horsemeat, dog meal and fresh milk.

Short doses of gamma radiation created a distaste in mice for alcohol.

Aquatic biologists tagged fish with ultrasonic signaling devices to study their long journeys across oceans to their home spawning grounds.

CHEMISTRY AND PHYSICS

Discovery of the omega minus meson, the heaviest known inhabitant of the atomic nucleus, furnished dramatic proof that the so-called "eightfold way," which provides a set of quantum numbers for classifying the strongly interacting nuclear particles, was valid; a ninefold way to describe the relationships of nuclear particles was also proposed.

Experiments in which "forbidden" modes of disintegration of the K_2° meson were observed cast doubt on the basic physics law of time reversal invariance, and experiments were therefore undertaken to test the proposition that there is a fifth force field in the universe.

Scientists continued their search for elementary particles, called "quarks," with a charge only one-third or two-thirds that of an electron.

A method was developed for making a three-dimensional picture, actually a photographic transparency of a diffraction pattern, that permits an observer to see behind objects in it by changing his viewing position.

Superconductivity was predicted and found in semiconductors, a class of materials many physicists had believed could not be superconducting, a discovery expected to provide physicists with a powerful means of studying superconductivity.

Protons and neutrons, the building blocks of atoms, were found to have a "jelly-like" structure, giving no sign of the hard core scientists thought existed in the atomic nucleus.

An important step toward controlling hydrogen fusion reactions for peaceful purposes to provide unlimited electrical energy was taken when what is called "burnout" was achieved in laboratory experiments.

A method was discovered for creating the highest frequency sound waves ever generated by bombarding a sapphire crystal with a giant pulse of light from a ruby laser.

Soviet scientists were reported to have discovered element number 104.

A new way of exploring atomic structure by combining ultraviolet light with speedy electrons was devised.

A macroscopic quantum system, formed by the wavelike properties of the electrons that make up the flow of current between two superconductors, was observed, giving firm experimental support for an important theoretical picture of superconductivity.

The Third Atoms-for-Peace Conference held in Geneva showed the aim of most nations is to achieve abundant economic nuclear power.

A fundamental method of crystal growth resulting in the formation of near-perfect crystals, called the vapor-liquid-solid mechanism, was developed.

The rare element lutetium was found to fission at a rate 100 times greater than expected, a discovery that could lead to revising theories on the formation of the universe since it affects the abundance of the elements.

A chelate polymer was used to remove every trace of copper and uranium from salt water in the Gulf of Naples and the elements were later liberated by addition of acid in order to obtain 1.4 micrograms of gold from 100 liters, the exact gold content of the sea water.

Kryptonates, materials made slightly radioactive by impregnation with krypton-85, can be made of virtually any solid material, thus greatly widening the radiotracer technique, it was reported.

Custom-designed scientific nuclear explosions were shown to be an important source for the production of synthetic elements heavier than uranium.

A major new chemical theory made possible the complete description of the behavior of 33 transition metals.

An atomic standard of time based temporarily on the invariant transition of the cesium atom, and replacing the definition of a second based on the annual orbit of the earth around the sun, was adopted by the 12th General Conference of Weights and Measures.

The first unequivocal synthesis of a simple cubane, symmetrical dicarbomethoxycubane, was reported.

Japanese and U.S. scientists independently found that the potent neurotoxin in pufferfish is identical to tarichatoxin.

A liquid laser that operates at near room temperature, using Eu-trifluorothenoylacetonate dissolved in acetonitrile, was developed.

Spectropolarimetry, based on principles known for many years, became widely used as a tech-

nique for unlocking many of the secrets of proteins by delineating their internal structure.

Studies of light and radio waves from individual flare stars confirmed that light waves and radio waves travel through space at the same speed.

By marking the individual light-receiving cells in the eye's retina without damaging them, a step was taken toward creating a research technique that may contribute to understanding the basic mechanisms of color vision.

An inter-agency Governmental task group concluded that the U.S. can economically build huge atomic reactors to convert sea water into fresh water and simultaneously provide economic electricity for cities and deserts near the sea.

The generation of electric power from the atom reached the historical point where atomic reactors fed on uranium were estimated to be competitive with some conventional power plants using coa and oil as fuels.

A new type of gas laser that can be modulated by varying the voltage on the grid in the tube was developed.

Semiconducting gallium arsenide diodes were used for the first time to pump a calcium fluoride laser, a step toward efficient operation of high-power crystal lasers.

The discovery and development of the maser principle, of which the laser is an offspring, brought to Dr. Charles H. Townes, provost of the Massachusetts Institute of Technology, and Profs. Nikolai G. Basov and Aleksander M. Prokhorov of the Lebedev Institute for Physics of the Russian Academy of Sciences the 1964 Nobel Prize in Physics.

Dr. Dorothy Crowfoot Hodgkin, a research professor of the British Royal Society and an Oxford Fellow, was awarded the 1964 Nobel Prize in Chemistry for her work in X-ray crystallography.

A simple theory of the behavior of electricity-making devices known as magnetohydrodynamic generators was confirmed by using one generator to predict the performance of the largest existing member of this family of machines.

How a bullet generates sound under water was studied in order to develop an auxiliary navigational and signaling system that might be used by an aircraft flying over water through fog to determine its position, or by a surface ship to signal a submerged submarine by firing a bullet into the water.

The U.S. offered to share with the world advances made in converting sea water into fresh water.

The ZGS, or Zero Gradient Synchrotron, went into operation at Argonne National Laboratory at an energy of 12.5 billion electron volts.

Cutbacks in the production of enriched uranium were announced, the first to start on July 1, and the second to take place gradually beginning in 1966, following Government studies showing that such decreases would still leave the country with adequate supplies of enriched uranium for both military and peaceful purposes.

The experimental breeder reactor, EBR-II, began to produce electricity.

ENGINEERING AND TECHNOLOGY

Plans were underway to produce "novawood," a class of materials made by impregnating wood with a liquid monomer and then exposing the treated wood to gamma radiation, which polymerizes the plastic into a versatile wood-plastic composite.

Picturephone service, by which the person on the other end of the line can be seen, began commercial operation June 25.

Development was revealed of the A-11 super warplane, which could fly faster than 2,000 miles an hour and carry bombs and tons of electronic instruments for detecting targets, aiming missiles and warding off enemy defenses.

Electronic equipment, featuring a new type of ceramic vacuum tube, was developed to keep U.S. vital communications and missile systems operating despite harmful radiation from nuclear bombs.

A ten-ounce radio transmitter that is only slightly larger than a pack of cigarettes, yet capable of sending signals across the United States was developed.

A new electronic communications system was built that in seconds transmits a letter, drawing, map or printed document over distances ranging from a few thousand feet to more than 4,000 miles.

The Federal Aviation Agency chose the Boeing Company and Lockheed Aircraft Corporation to compete in a run-off to select the prime contractor for building the first U.S. supersonic transport; General Electric Company and Pratt & Whitney Aircraft Division were selected to compete for building the SST's jet engines.

The Department of Interior's Bureau of Mines signed its first contract with industry to enter the field of undersea mining for recovery of minerals for fertilizers and other uses.

The Chesapeake Bay Bridge-Tunnel, a 17.5-mile span across the mouth of Chesapeake Bay, was officially opened in April.

The Verrazano-Narrows Bridge linking New York and Staten Island, the world's longest suspended span, with 4,260 feet between the two supporting towers, was opened to traffic in November.

Gas lenses that show promise for guiding laser beams in pipes for communication over long distances were devised.

The Federal Aviation Agency held two series of tests to determine the effects of sonic booms, such as would be created by the proposed supersonic transport.

A technique called photochromics was developed to enable astronauts to carry 12,000 pages of instructions and reference data in a three-pound package the size of a phone book.

The Navy's COIN (counter-insurgency) aircraft that can drop bombs, shoot rockets, take off and land on short stretches of bumpy roads and fly on truck gasoline at more than 300 miles an hour was reported ready for anti-guerrilla fighting next year.

Researchers created a design technique to avoid rapid changes in combustion pressure of rocket motors, thus averting the spectacular rocket blow-ups that sometimes occur on the launching pad.

Eyeglasses that automatically darken as the light intensity increases were developed using submicroscopic crystals of silver halide.

A new finish, made by applying formic acid and trimethylolmelamine to a fabric, was developed to make cotton fabric both rot resistant and weatherproof.

A system called "Microvision," using a series of microwave transmitters placed along the sides of a runway, was developed to help pilots approaching fogbound runways "see" the landing strip almost as well as on a clear-night landing.

An infrared detector in which a light beam passes through a column of air to register the concentration of carbon dioxide was built in an attempt to pinpoint areas of heavy air pollution.

Synthetic oils made from organosilicons and fluorocarbons and capable of withstanding new extremes of temperature, pressure, corrosion and radiation were developed for jet and rocket engines.

A new mathematical technique was perfected with the aid of a computer to take electrical "pictures" of the human heart.

An electronic switching system that offers a variety of new telephone services, which can be programmed into magnetic memories, was demonstrated.

Light waves were modulated in a new way using gallium phosphide diodes.

A new type of light-weight, high-strength laminate and a process for deep drawing this material into a variety of shapes were developed.

A quick method for determining the gas and carbon content of thin films was developed.

A structure for semiconductor devices and circuits that uses strong electrical leads to provide mechanical support and to make electrical connections was developed.

The life expectancy of ball bearings was increased almost tenfold by using molybdenum disulfide as a lubricant.

A significant advance in producing fine-celled foamed polymers was achieved by using metal and alloy particles to nucleate bubbles from solutions of gases in molten polymers.

Polyurethane casting compounds that can be cured rapidly at room temperature were developed.

A class of laser materials typified by magnesium fluoride doped with nickel or cobalt ions was discovered.

An alloy with the highest residual induction of any permanent magnet material, yet so malleable and ductile that it can be rolled to the thickness of a human hair, was developed.

The Air Force XB-70 supersonic bomber was turned into a "research" plane, although in the past seven years taxpayers have paid $1.5 billion to have it built as a bomber.

The F-111 dual-service jet fighter plane, a new name for the controversial TFX, finally made its appearance, with a variable-swept wing that adjusts during flight to give maximum stability and minimum drag at subsonic and supersonic speeds for both low and high altitude flight, and an ejectable cockpit that separates en toto from the plane in emergencies.

A computer system that can simultaneously give individual lessons to a number of students in a wide variety of subjects was being readied to teach a series of college courses in an experiment to evaluate "computer assisted" instruction.

A camera-processor-projector device was built that can photograph an image and then project it up to movie screen size eight seconds later.

The tallest man-made monument in the United States, the Gateway Arch, which stands 630 feet high and commemorates the westward expansion after the Louisiana Purchase, neared completion at St. Louis, Mo.

GENERAL SCIENCE

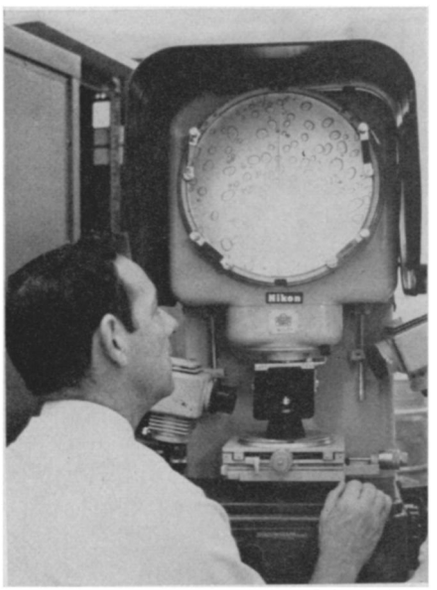
Red China detonated her first atomic bomb on October 16, increasing the number of countries in the "Nuclear Club" to five and focusing attention on the "nth" country problem.

The resignation of Nikita Khrushchev as Premier of the U.S.S.R. was reportedly due to some of his questionable policies, including those in agriculture that have now lost their favored status in Soviet science.

The Warren Commission Report on the assassination of President John F. Kennedy showed that the Commission had taken full advantage of all available scientific techniques to reach the conclusion that Lee Harvey Oswald, acting alone, shot President Kennedy on November 22, 1963.

Cracks in the Cold War facade combined with the Administration's economy drive served to highlight the problem of how the U.S. can convert to peacetime pursuits as national security needs are met and the international political situation improves; and a high-level interdepartmental Government Committee was appointed by the President to evaluate and coordinate the plans of Federal agencies to cope with shifts or cuts in defense spending.

If the test ban treaty, now in its second year,



Bell Telephone Laboratories

BUBBLES ANYONE? — Fine-celled plastic foams, produced by using metal particles to nucleate bubbles from solutions of gases in molten polymers, are being examined on a projection microscope at Bell Telephone Laboratories.

continues, about ten years from now baby teeth will once again approach their previous, non-radioactive state, it was predicted.

Congressional committees held hearings and appointed panels to help in establishing policies to be followed in the complex interrelationship between the Federal Government and scientific activities, including social issues, the geographical distribution of Federal funds for research and development, the level of Federal support of basic research necessary to maintain the U.S. in a position of scientific leadership, and the fields of science not being adequately pursued because of lack of funds or manpower.

The United States proposed to the 18-nation Geneva Disarmament Conference topics for negotiation designed to extend the current slowdown in the arms race, including a "verified freeze" of the numbers and types of bombers and missiles capable of delivering strategic nuclear weapons.

The controversy concerning use of biological and chemical warfare continued, and the U.S. was urged to seek an international agreement prohibiting "first use" of these weapons.

The election of President Lyndon B. Johnson meant that the Government's drive against poverty, disease, pollution of the environment and inadequate urban transportation systems would be strengthened, as would its programs to foster national beautification and education.

The world population is increasing by almost 120 persons each minute, or 63 million each year, the highest rate in recorded history, according to the United Nations.

Research and development accounted for more than 15% of the total budget of $97.9 billion submitted to Congress by President Lyndon B. Johnson for the year ending June 30, 1965.

A major issue in the Presidential election was who should have absolute control over the use of nuclear weapons.

The United States announced to the 18-nation Geneva Disarmament Conference that one of its biggest nuclear power reactors would be placed under permanent international inspection in a move designed to halt the spread of nuclear weapons and such inspection was made.

The National Science Foundation announced its long-awaited Science Development Program, designed to aid institutions in developing stronger science programs through grants by building up their science departments during a five-year period.

The National Academy of Sciences issued a report calling for adjustments in methods used by the Federal Government to support universities and scientists and in the way universities and scientists use public funds.

The nuclear-powered submarine Thresher, lost with 129 men aboard in April 1963, was located and photographed by the Navy's deep-diving bathyscaph Trieste II and Navy cargo ship Mizar, which towed an underwater camera, in a search continued because of its international implications.

Legislation was signed ending the Government's monopoly on nuclear fuel and authorizing private ownership of fissionable materials in a step-by-step program that would put the atomic power industry on its own by 1973.

Congress authorized the Agency for International Development (AID) to conduct research into the population problems of the world.

Dr. Donald F. Hornig was sworn in as the President's Science Advisor on January 24, 1964, replacing Dr. Jerome B. Wiesner.

The Transit navigational satellite launched from Vandenberg Air Force Base in April with a SNAP-9A nuclear battery fueled by a kilogram of highly radioactive and toxic plutonium-238 failed to go into orbit and was lost; it was designed to disperse in minute particles at an altitude above 120,000 feet and later found to have done so.

A UN Committee recommended steps to be taken by national and international agencies to help developing countries make the best use reference service of the Library of Congress.

Congress acquired a new source of scientific information with the establishment of a science research and policy division in the legislative reference service of the Library of Congress.

As the North Atlantic Treaty Organization entered its 16th year, the U.S. proposed establishment of a NATO multilateral nuclear force, an Allied owned and operated mixed manned fleet of surface ships armed with nuclear-tipped Polaris missiles over which the U.S. would have veto power.

European and U.S. researchers entered into an agreement to join in building and operating an experimental fast breeder reactor near Fayetteville, Ark.

Medical reports at an international conference of air pollution experts focused attention on the correlation of air pollution with the occurrence of such diseases as cancer, chronic lung ailments, anemia and stunted growth.

Congressional hearings on the plans of the U.S. auto industry to control auto exhaust failed to show why car manufacturers were reluctant to make the modifications now mandatory for cars sold in California available in the other 49 states.

Using nuclear explosives to dig a new Central American canal was suggested as being cheaper and generating less fallout than previously thought.

A program for intensive joint development by two Government agencies of plants developing electricity from nuclear reactors and also desalting water was approved by President Johnson, and late in the year the United States and Russia agreed to an exchange of information concerning such double-barreled installations.

Eleven scientists were named to receive the National Medal of Science, and of the 31 living persons awarded the Presidential Medal of Freedom, the Nation's highest civilian award, five were given to scientists.

The late Herbert Hoover, the 31st President of the United States, held honors no other President has held, including membership in the National Academy of Sciences.

A new information clearing house in the Department of Commerce was set up to make available to the public all Government-generated developments in science and technology.

Dr. Mary I. Bunting, president of Radcliffe College, became the first woman to serve as an Atomic Energy Commissioner.

Dr. J. Robert Oppenheimer was presented by President Johnson with the Enrico Fermi award, the Atomic Energy Commission's highest honor.

Two great physicists died, Drs. James Franck and Leo Szilard, both known for their political as well as scientific interests.

The National Academy of Sciences took steps to establish a National Academy of Engineering.

A new $7 million college scholarship program was established by the Ford Foundation for talented Negro high school students, based on need.

Scientists took an active part in the election campaign by forming various organizations backing either the Democratic or Republican Presidential nominee.

The Smithsonian Institution's new addition, the Museum of History and Technology, was dedicated January 22.

The population of the United States, including military personnel abroad, reached 192 million on June 22, and exceeded the 193 million mark exactly four months later.

An increasing proportion of U.S. doctorates are being awarded by schools in the southern and western sections of the country, a study by the National Academy of Sciences indicated.

The planned English Channel Tunnel connecting England and France received the approval in England of the new British Government.

The 88th Congress enacted more significant natural resources and conservation legislation than any Congress in history.

GEOPHYSICS

Biological chemical compounds, similar to those reported found in meteorites, were discovered in billion-year-old rocks from Michigan, giving new clues to the origin of life on earth.

A layer of viscous rock, 300 miles thick, beginning some 60 miles below the earth's surface and extending around the earth, may be the source of lava for active volcanoes, it was reported.

A new theory about the earth's structure stated that a ring of dense rock, 300 miles thick, lies between a fluid outer core and the heart of the earth.

A big bulge of high-energy radiation was detected far beyond the usual reaches of the earth's radiation belts.

Giant scissors-like winds, whipping along at 50 miles or more high in the atmosphere, may lead to disturbances in the ionosphere that reflects radio waves for long-distance communications.

The controversy over the Mohole deep-drilling project continued, with added troubles coming from a new theory holding that continental land masses have "roots" extending deep into the earth and that the composition of the earth under the seas is not the same as it is under the continents. which would mean that no single Mohole core sample would be truly representative of the whole earth.

The Good Friday earthquake that shook Alaska March 27, one of the most severe known, killed 114 people, raised parts of the ocean floor to the greatest recorded height of 50 feet, and caused waves six feet high in the Gulf of Mexico.

Scientists have been developing strangely designed, mobile vehicles equipped with windows, lights and arms to inspect sea life, currents and geology from several hundred to thousands of feet beneath the surface: Diving Saucer, Deepstar, Alvin, Aluminaut and SPAR.

A severe drought plagued most areas of the United States east of the Rocky Mountains.

One of the most extensive sources of underground water in the United States was located in huge limestone rock formations, some as thick as 1,000 feet, sloping toward the sea under the Southeast.

Shells of microscopic fossils from ocean bottoms indicated the earth's ice age started about 1.5 million years ago, half a million years earlier than scientists had thought.

The first evidence of former volcanic activity on the Arctic Ocean floor was discovered.

The day gets longer by two seconds every 100,000 years, it was reported.

A new world record for rainfall during a 24-hour period was set when 49.13 inches of rain fell on Paishih, Taiwan, Sept. 10 and 11, 1963, the U.S. Weather Bureau reported.

A volcano boiled out of the ocean south of Iceland.

Scientists cooperating in the worldwide program of the International Years of the Quiet Sun, or IQSY, found that the periods of solar calm they had hoped for actually occurred.

The Amazon River was found to have a flow rate 12 times that of the Mississippi, with an average discharge of water into the ocean of 3.4 billion gallons per minute.

Radioactive wastes could be safely stored for hundreds of years in crystalline rock about 1,500 feet beneath the earth's surface in South Carolina, it was reported.

Four oceans and three submerged mountain ranges lie beneath the snows and ice of the Arctic Ocean, geologists discovered.

Vast movements of heat generated by radioactive materials deep within the earth are forcing the continents to drift apart, it was theorized, but another geophysicist reported that the continents do not drift but are anchored 300 miles deep in the earth's mantle.

More than 9,000 feet of rock fragments, sand, silt and clay at the bottom of the Atlantic Ocean, east of the Argentine coast, was reported to be the greatest pile of sediment in any ocean basin surveyed to date.

A current of water flows slowly to the east under the Indian Ocean, close to the equator, oceanographers with the International Indian Ocean Expedition found.

Two bands of tiny particles surrounding the earth were found by shooting intense bursts of concentrated light from a laser into the atmosphere.

A new kind of "whistler," or low-frequency sound, was discovered high in the earth's atmosphere.

A magnetic effect of the moon that extends like a giant teardrop at least 68,000 miles into interplanetary space away from the sun was detected for the first time by the Interplanetary Monitoring Platform, or IMP.

A new electronic sonar system has been developed for "photographing" the ocean floor 20,000 feet under the sea.

The rare form of ball lightning was reported to occur from a "leak" sprung from the lightning stroke as it changes direction or from a concentration of high electrical fields around a conductor.

After two years of not being hit by hurricanes, the United States was damaged by four hurricanes this season—Cleo, Dora, Hilda and Isbel.

A new way to produce crystals in clouds by sprinkling them with the organic chemical, phloroglucinol, was discovered.

Successful seeding of tropical cumulus clouds with silver iodide to make them grow was stated to be the first step toward making meteorology an experimental rather than a purely observational science.

A radioactive device was used to measure the amount of humidity in the air.

A special instrument to forewarn a pilot of turbulence in clear air was under development for installation in jet cockpits.

High electrical currents 12 to 24 miles beneath the Andes Mountains of Peru and Bolivia were studied, because this electrical "hot spot" is believed related to huge crustal movements associated with earthquakes and active volcanoes in that region.

For the first time a geologist located what is apparently the earth's equivalent of a lunar mare in Ontario.

The northern tip of an undersea mountain ridge was charted in the Pacific Ocean just south of Panama.

Satellite photographs showed the Bermuda Islands were 220 feet farther north and 105 feet farther west than the last survey in 1959 indicated.

An international congress on large dams was held to investigate the causes of failures of large dams, in order to avert tragedies such as the dam failures last year at Baldwin Hill, Calif., and the three in Montana.

Mysterious tiny glass bubbles containing fresh water, never seen before, were discovered in the rocks of Great Swan Island, in the Caribbean Sea.

A hydrographic survey revealed that the oceans have advanced upon the U.S. shores as much as nine inches during the past quarter century.

More than 30 possible routes were considered for a second canal connecting the Atlantic and Pacific Oceans.

Scientists were using thousands of pictures taken by weather satellites to study cloud formations for indications of the births of violent storms or hurricanes.

Huge trenches, gouged out ages ago by massive onrushes of mud, were found in the Indian Ocean floor.

Heat from the decay of radioactive elements during the earth's early history was four to eight times higher than it is now, it was reported.

There is more sunshine than usual when the moon is between first quarter and full moon, and between last quarter and new moon, it was reported.

A 5,000-foot-diameter crater-like depression discovered in Kentucky was reported to have been formed by the impact of a meteorite.

MEDICINE

Cigarette smoking was convicted of causing lung cancer and of contributing substantially to deaths from other ailments in the Smoking and Health Report of the Advisory Committee to the Surgeon General of the Public Health Service.

Frozen sperm was successfully used to father four babies, who were later reported developing normally.

Electrically charged gold leaves were used for the first time on humans as well as animals to prevent troublesome adhesions and to help patch blood vessels, in some cases replacing sutures.

Cooley's anemia, one of the most severe and complex children's blood diseases, which is treated mainly by transfusions, was successfully treated by folic acid, a chemical normally found in the body.

Cheap plastic or nylon coils that can be inserted into the womb by a physician were reported the greatest hope for birth control in developing countries because they cost only about two cents each.

The rhythm method of birth control, advocated by the Roman Catholic Church, was shown to fail in 40 out of 100 women because it is not practiced correctly.

Asian flu and other forms of influenza were successfully treated with a new experimental drug, 1-adamantanamine, the first known synthetic compound given by mouth to be effective against these virus infections.

Trichinosis, caused by eating insufficiently cooked pork, was cured for the first time by the investigational drug thiabendazole.

Tranquilizing drugs were found to be misnamed and to show broader effects than previously suspected; the phenothiazines, the most widely used tranquilizers, were reported to improve the passive, withdrawn patient even more than the agitated, abusive one.

The concentrated light beam of the laser was used for experimental treatment of melanoma, a highly malignant form of skin cancer.

Hepatitis vaccine was believed nearer achievement as a result of a report that human hepatitis virus had apparently induced disease in a laboratory animal.

Intrauterine blood transfusions were pioneered for babies threatened with hemolytic disease of the newborn.

A simple, sensitive method of detecting kidney disease in the general population was reported as measurement of urinary lactic dehydrogenase activity.

Cholesterol-depressant diets and daily doses of cholestyramine lowered blood cholesterol levels and maintained the reduced levels for as long as four years without serious side effects.

Great promise for research in organ transplantation was seen in the perfection of a method for measuring in animals the lifetime of transplanted cells.

A simple method of warming blood for transfusions was reported to be an important contribution to the safety of patients in the operating room.

Patients with Hodgkin's disease, a malignancy of the lymph nodes and glands considered fatal, were reported improved after treatment with a new compound that belongs to the group known as methyl hydrazines.

Fluorides, which harden tooth enamel, were shown to have a pain-relieving effect on a destructive bone disease of old age called osteoporosis.

About 60% of tuberculosis patients were reported cared for adequately at home by treatment with drugs such as isoniazid and PAS, or para-amino-salicylic acid.

Polonium, one of the scarcest natural radioactive elements known, was indicted both in this country and in Russia as a cancer-causing element in cigarette smoke.

The theory that virus causes cancer in humans was supported by research showing that Rous sarcoma virus produced malignancy in infant monkeys, the first known virus cause of cancer in primate animals.

Virus-like particles obtained from the blood of acute leukemia patients were found to be similar to mouse leukemia viruses when studied with the aid of the electron microscope and the fluorescent antibody technique.

Cancer cells were found to aid in their own destruction when checked by mitomycin, an antibiotic that attacks DNA, causing it to lose its ability to reproduce.

Asthma sufferers improved their breathing capacity by singing or playing the flute, activities that use their lungs nearly to the fullest extent, research showed.

The heredity factor was found to play an important part in tooth decay among mongoloids who had no dental caries in spite of gross neglect of mouth hygiene.

A relationship between diminished oxygen supply during pregnancy and heart defects at birth was established by scientists working with mice in the rarefied atmosphere of a mountain peak.

Clam and oyster juice were discovered to contain a substance called paolin that, although still in the animal experiment stage, shows promise in treating polio, flu and even cancer.

Typhoid carriers were successfully treated in England by a semisynthetic penicillin called ampicillin, although the surest way to end the carrier state is still removal of the gallbladder.

One of a series of nonsteroidal drugs showing antiarthritic action, n-arylanthranilic acid, was scheduled for clinical trials.

Football players were reported to be helped to recover from the swelling of sprains, fractures, lacerations and ruptured muscles by an enzyme drug derived from papaya.

High-pressure oxygen given to pregnant hamsters in a hyperbaric chamber caused abnormalities in fetuses.

More than 1.3 million former cancer patients now living in the United States were reported "cured" of cancer in the sense that they have had no evidence of the disease for five years.

Replantation of a severed arm was reported successful in a 12-year-old boy and a 44-year-old man, both of whom are living nearly normal lives.

An organic ingredient of saliva was shown to be responsible for tartar on the teeth, a discovery that could lead to relief of the gum diseases often causing loss of teeth.

A new type of thermometer that holds a tiny wire gently against the eardrum was reported to have promise in hospitals for recording automatically the temperatures of many patients at the same time.

A new antibiotic called Ceporin, developed in England, was reported to take effect within half an hour, with activity continuing for eight hours.

Autoimmunity, or self allergy, was blamed for the muscle weakness disease, myasthenia gravis.

A one-minute test for diabetes was developed in England using a strip of impregnated paper on which is placed one drop of blood, to determine by color change if the patient has an abnormal amount of sugar in his blood.

A flexible tube for use in examining the intestines and other body parts, formerly accessible only by surgery, was developed in Israel.

Hyperbaric chambers were increasingly installed in hospitals for treatment of conditions that might be helped by high pressure oxygen, such as unsuccessful cardiovascular surgery, barbiturate poisoning and stroke.

Ultrasound was successfully used to remove a brass chip from an exploding rifle bullet from the eye of an eight-year-old boy.

Temporary artificial limbs of plaster pylon, a plastic material, were developed to help injured people back on their feet in a matter of weeks instead of months after amputation.

An artificial heart, in the form of a plastic auxiliary left ventricle, worked successfully in 72 dogs and will be a model for a similar device for humans whose heart muscle is weakened by chronic blood vessel insufficiency.

Individual mouth guards made from plastic molds for football players were designed and recommended to replace poorly fitting mouthpieces made from a common pattern.

A tiny implantable pacemaker suitable for babies born with slow hearts or for infants who have heart block following surgery on their hearts was reported ready for testing after five years of preliminary work.

Penicillin allergy was detected in a simple test that consists of injecting into the skin a solution of penicillolyl-polylysine and watching the blister raised to see if it enlarges or if red appears around it.

Sight was reported improved by four drugs—nicotinic acid, Roniacol, Priscoline and Arlidin—when tried on elderly Canadian patients who had a variety of eye disorders.

Cryogenic surgery, which involves freezing tissues, was successfully used for Parkinson's disease, or shaking palsy, and to destroy pituitary tissue with a minimum amount of risk to the brain.

Infants of Rh-negative blood type mothers were saved in some cases as a result of "tapping" the amniotic fluid before birth and, if an examination of the fluid warrants it, delivering the baby early.

A new elastic mesh suit was made commercially available to help patients who are subject to fainting spells when standing due to low blood pressure from an unknown cause.

Fast pictures of radioactive substances, injected to detect brain tumors and defects in internal organs, were made by a new complex camera that is a marked improvement over previously used scanning-type apparatus.

A poison known commercially as Raticate Radicide was found to kill rats but have no harmful effects on other animals, including rhesus monkeys and chimpanzees, which suggests that humans also would not be harmed.

The 1964 Nobel Prize in Physiology or Medicine was shared by a Harvard professor, Dr. Konrad E. Bloch, and Prof. Feodor Lynen of the Max Planck Institute in Munich for their discoveries concerning the mechanism and regulation of cholesterol and fatty acid metabolism.

A new way to detect throat cancer was reported in Yugoslavia—using an ultraviolet lamp to produce fluorescence after giving a patient the antibiotic tetracycline, which is known to respond to fluoresence.

The first case of drug resistance in a family was discovered among seven members of three generations who showed extraordinary resistance to coumarin anticoagulant drugs.

Migraine headaches were prevented by a drug called Sansert, whose generic name is methysergide.

Research pointing to a possible vaccine against multiple sclerosis in humans was seen in reports that a protein substance injected into experimental animals stopped experimentally induced brain inflammation, called experimental allergic encephalomyelitis (EAE).

Danger of parrot fever, or psittacosis, being transmitted by pet birds to their owners and handlers was lessened by wholesalers putting an antibiotic in the feed continuously for 15 days before shipping them to pet shops.

Endrin, a pesticide used with the approval of the U.S. Department of Agriculture since 1954, was found to have excess residues on tobacco, and approval of its use on this product was withdrawn.

Transplantation of wisdom teeth, or third molars, to the first molar position was reported successful when done in the same young adults.

Cholesterol levels were lowered by surgery that shut off the lower third of the small intestine, thus bypassing the ileum, which is the most important site of cholesterol absorption.

A monkey's brain was kept alive seven hours outside its body for the purpose of study unencumbered by surrounding tissues, and plans were underway to connect individual monkey brains to some part of another monkey's anatomy, using the same circulation system.

Aspirin was metabolized more quickly by pregnant animals than by other female animals, an English study showed, leading to the suggestion that the drug is accumulated by the fetus, or that changes in maternal hormones during pregnancy could be the cause of its rapid metabolism.

Epidemics of measles, encephalitis and meningitis occurred in the United States.

PATENTS

The National Aeronautics and Space Administration began enforcement of a new policy to waive patent rights to inventions made under its research and development contracts with industry, either at the time a contract is signed or within 60 days, except as prohibited by law.

The two 1963 Nobel Prize winners in chemistry each received a patent for research that laid the groundwork for an entirely new field of chemistry, using the by-products of oil refineries to produce better plastics, textiles and rubbers. Patents 3,119,799 and 3,119,854.

Other notable and interesting inventions patented during the past year include:

A strange flying machine, called an Ionocraft, that can relay messages and also detect and intercept enemy missiles. Patent 3,130,945.

Element 95, americium, the first patent awarded for an element, to Nobelist Dr. Glenn Seaborg. Patent 3,156,523.

Microcircuits that provide as much as a 100-to-1 size reduction from conventional transistor circuitry. Patents 3,138,721, 3,138,743, 3,138,744 and 3,138,747.

A device to detect nuclear blasts, used at 100 target areas around the country. Patent 3,147,380.

A process for joining metals together using high explosives. Patent 3,137,937.

An improvement in the electron microscope that produces the pictures on plates or screens entirely outside the vacuum. Patent 3,149,258.

A large-scale nuclear power reactor that would create more fissionable fuel than it consumed, which could also be used for saline water conversion. Patent 3,154,471.

A method of making direct photographic positives by a process called photosolubilization. Patent 3,155,506, 507, 514 and 516 through 519.

A device that can find bombs hidden in airplane-bound luggage by detecting the radiation seeded in explosives during manufacture. Patent 3,146,349.

A solar engine that uses the sun's radiant energy to power spacecraft, run refrigerators and operate water pumps in remote areas where no electricity is available. Patent 3,117,414.

A radar system for detecting submerged submarines from an aircraft by bouncing radio waves off the water. Patent 3,153,236.

A process that uses a delayed chemical reaction to give cotton fabrics a "memory" so that they will take a crease, keep a shape and be wrinkle resistant. Patent 3,138,802.

A combined helicopter-airplane, called the Pathfinder, that can take off either vertically or on a short runway. Patent 3,138,349.

A system that automatically locks all doors on a car during a collision to prevent occupants from being thrown out of the car. Patent 3,151,698.

An economical process for making gasoline from coal by using only the coal extract that can be easily converted. Patent 3,143,489.

A method that uses the earth's magnetic field to stop the spin of satellites in order to get more stable radio transmissions. Patent 3,114,518.

An alarm that sounds automatically when a ship is on a collision course with another moving ship. Patent 3,149,325.

A class of synthetic drugs, called "novel bisacetamides," that have been used successfully in the treatment of ulcers. Patents 3,135,750, 3,135,791, 3,135,792 and 3,135,793.

A "paste" made from the bones and tissues of calves that can be used to graft human bones together. Patent 3,126,884.

A chemical, called benzanthroneacridine, that can be painted on utility poles to protect them from the costly damage of woodpeckers. Patent 3,140,913.

The steroid compounds, prednisone and prednisolone, that are widely used to treat arthritis and other diseases. Patent 3,134,718.

A method that uses light to measure the pulse rates of human beings. Patent 3,139,086.

A "free piston hydraulic pump" that could be used to power automobiles. Patent 3,145,660.

A telephone network switching system that provides the military with elaborate automatic communications and links 750,000 telephones in 8,000 Government offices in more than 400 cities. Patent 3,150,236.

An airplane with two sets of wings, one for

flying faster than the speed of sound, the other for flying more slowly. Patent 3,155,344.

A tactile communication system for sensing coded vibrations with the fingers. Patent 3,157,853.

An electric arc that produces a ball of plasma, or ionized gas, that is hotter than the sun's surface for use as solar simulator in enviromental test chambers. Patent 3,136,915.

A high-speed surgical drill powered by a tiny gas turbine engine that can be used by dentists, or by surgeons operating on the heart and brain. Patent 3,128,079.

A method of launching rockets that uses a rocket sled zooming on rails down an incline then back up a slope to give added push to the missile's thrust. Patent 3,134,300.

An agricultural spray, consisting of hydrated lime, bentonite, kaolin and Celite, that reflects the direct rays of too strong a sun in summer and insulates the crops against killing frosts in winter. Patent 3,120,445.

A suspended dome that uses the principle of the catenary widely used for suspension bridges. Patent 3,139,957.

An inflated stomach balloon apparatus that uses the same heat exchange cycle as a conventional refrigerator to stop bleeding stomach ulcers. Patent 3,125,096.

Numbers following items are U.S. patent numbers. Printed copies of patents can be obtained from the U.S. Patent Office at 25¢ each. Order by number, do not send stamps, and address orders to the Commissioner of Patents, Washington, D. C. 20231.

SPACE

The U.S.S.R. launched a three-man spacecraft called "Sunrise," the only manned shot by any country during the year, with an astronaut, a doctor and a scientist who did not wear spacesuits; the Sunrise used retrorockets as brakes to permit a soft landing.

Nimbus I, launched August 30, used an ingenious infrared TV camera to take unusually clear photographs of the earth's cloud cover, including the first night-time pictures ever made.

On September 17, it was announced that the United States has two already-working systems "with the ability to intercept and destroy armed satellites circling the earth in space."

A panel of the National Academy of Sciences recommended that the United States make Mars, not the moon, its main concern in space, with particular emphasis on the search for extraterrestrial life.

Mariner IV, following on the heels of its unsuccessful predecessor, made a good start late in November at being the first man-made object to take a close look at Mars, with arrival expected next July.

Two days later, the Russians announced the launching of their own Mars probe, Zond 2, although a troublesome power supply may have doomed the mission.

Early in the year the Soviet Union scored its first multiple satellite launching, with Elektrons 1 and 2 riding up on the same rocket to study the Van Allan radiation belts, followed in July by 3 and 4.

The 4,316 beautifully clear photographs of the moon taken by Ranger VII gave resolutions even higher than expected and were 1,000 times better than any previously possible.

SERT I flight from NASA's Wallops Island Station on a ballistic trajectory more than 2,000 miles over the Atlantic Ocean was the first successful test of an ion propulsion engine.

The largest man-made satellite in the sky, Echo 2, a mirror-finished balloon as big as a 13-story building, was launched January 25 and is being used for experiments by the United States, United Kingdom and the Soviet Union.

The first Orbiting Geophysical Observatory, porcupinish OGO-1, carried 20 experiments of various kinds into orbit, of which 17 are sending back information.

NASA began the process of selecting scientists-astronauts who will begin training next year.

The Syncom 3 communications satellite transmitted live pictures of the Olympic Games in Tokyo from a position 22,300 miles above the intersection of the equator and the international date line.

The first live pictures between Japan and the United States were transmitted during January by Relay 2, which is equipped to handle TV, radio and two-way telephone conversations.

See Front Cover

The spider-like Lunar Landing Research Vehicle, or LLRV, designed to give astronauts practice in landing the Lunar Excursion Module on the moon, was completed and successfully tested.

The Air Force expanded several Top Secret series of "sky spy" satellites, including Samos, Midas and Vela Hotel, equipped for such tasks as observing enemy rocket trails, missile bases and nuclear tests.

The Soviet Union continued its Cosmos satellite program, launching numbers 25 through 50.

The heat of reentry into the atmosphere was measured by Project Fire, using a vehicle shaped like a Mercury capsule, launched from Cape Kennedy to a height of 520 miles, then "launched" back again from about 80 miles up to achieve a top speed of nearly 26,000 miles an hour, highest ever achieved in free flight by a man-made object.

Atlas-Centaur 3, prototype of the rocket that will "soft land" the un-manned Surveyor spacecraft on the moon, was finally launched.

American manned flight hopes, embodied in the two-man Gemini program, were delayed until 1965, although Saturn rockets, 5, 6 and 7 carried mockups of the Apollo lunar craft and developed an effective new guidance system.

• Science News Letter, 86:389 December 19, 1964

BIOTECHNOLOGY

Imitation Bone Made From Clay-like Material

➤ OUT OF A CLAY-LIKE material made from aluminum, science has artificially fashioned imitation human bone.

The new material promises to serve the living body almost better than the natural skeleton. It may also be used to replace eyeballs and develop non-sparking, non-reflective surgical tools.

This ceramic was produced by the cooperative research of a prominent orthopedic surgeon, the nation's largest pottery giftware manufacturer, and a major pharmaceutical firm.

Initial experiments on rabbit knee bone transplants at Baxter Laboratories, Inc., Morton Grove, Ill., showed that animal tissue will stick to the material as natural bone does.

However, three to four years of further evaluation is necessary before its safety for human use can be determined.

The material, known as Cerosium, is made from a porous ceramic composed mainly of an oxide of aluminum that is impregnated with epoxy resin, an inert plastic compound.

This combination provides a tough, nonreactive, flexible material, very similar to bone.

Haeger Potteries, Dundee, Ill., produced the ceramic material at the suggestion of Dr. Lyman Smith, Elgin, Ill. surgeon and assistant professor at Northwestern University.

• Science News Letter, 86:396 December 19, 1964

MEDICINE

Artificial Heart Outlook

➤ PARTIAL OR TOTAL heart substitutes are among the promising outlooks for the future, Dr. Bert K. Kusserow of the University of Vermont College of Medicine, Burlington, said at a meeting of the New York Academy of Sciences' division of instrumentation in New York.

In his own work, Dr. Kusserow has made drastic changes in the electrically driven pump he originally implanted in the abdomen of animals.

By placing his pump immediately outside the chest wall, Dr. Kusserow found that it worked just as well, was easier to replace and was less irritating to tissues.

The newer pump can carry approximately one-third of the heart load, supplying the left ventricle.

Although dogs formerly could be perfused by the pumping heart for only ten and a half hours, experimental animals can now be perfused more than two days, fully conscious and walking around.

There is less destruction of the blood elements with the newer, "gentler" instrument, and the pump is less likely to cause blood clotting.

Surveying the numerous investigations in artificial heart research, Dr. Kusserow told the meeting that one of two basic approaches is being made. Some scientists propose total removal of the heart, followed by complete replacement with a blood pump. Others aim only at partial substitution and augmentation of existing heart function by a small pumping device coupled with the beating heart.

There has been considerable variation in pump design, including roller, ventrical, pendulum and sac types, Dr. Kusserow said. In general, such pumps have been driven by direct coupling with conventional power units such as small electric motors, cylindrical coils or wire, called solenoids, and compressed gases.

A few experiments are on record in which systems of rotating magnetic fields or inductive coupling with stationary coils have been used to transmit power across the intact body wall to an implanted pumping device or other receiving unit.

Attempts have also been made to power pumping systems biologically with skeletal muscle.

Although a number of difficulties remain, Dr. Kusserow said it appears from experiments with animals that pumping systems can be constructed safely enough for cautious use on selected humans.

• Science News Letter, 86:396 December 19, 1964