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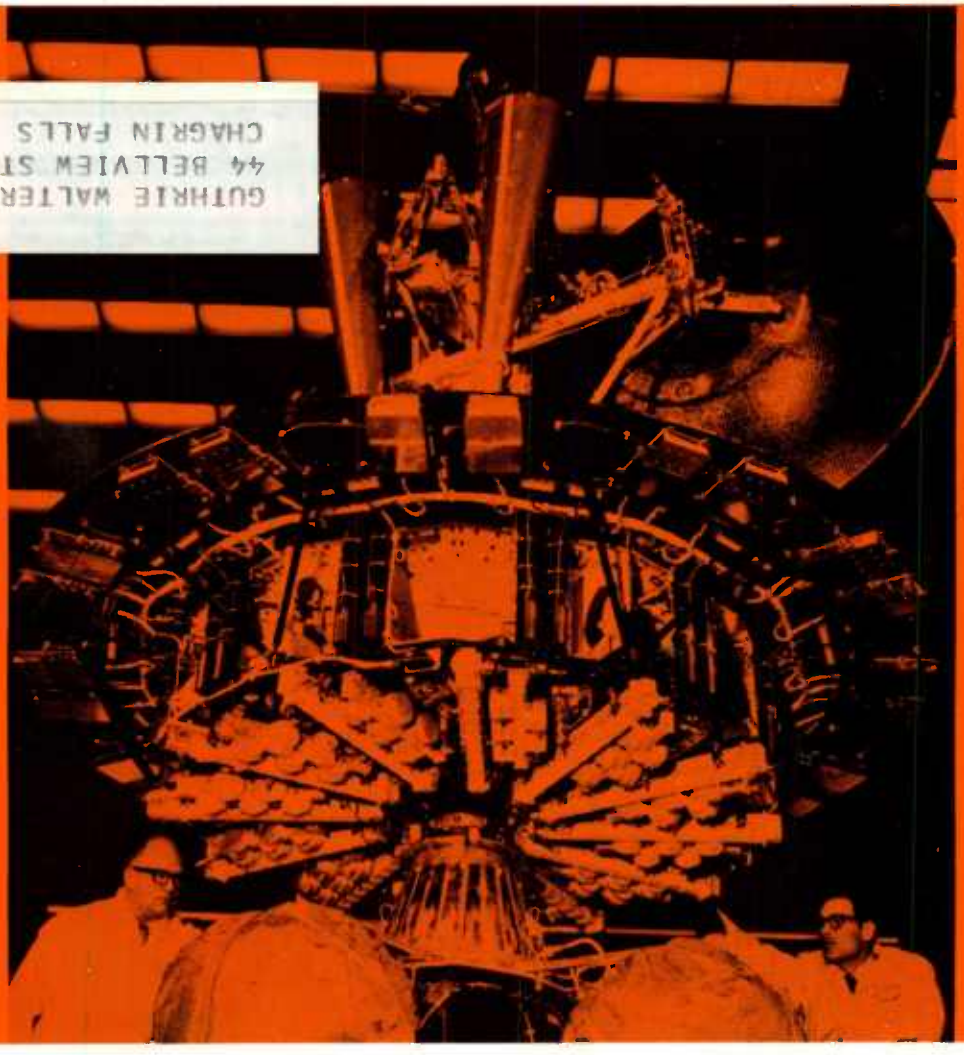
President Nixon's Report . . .

on U.S.-U.S.S.R. Agreement on Science and Technology



Engineers check maze of electronic circuitry in INTELSAT satellite.

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(SEE COVER STORY)

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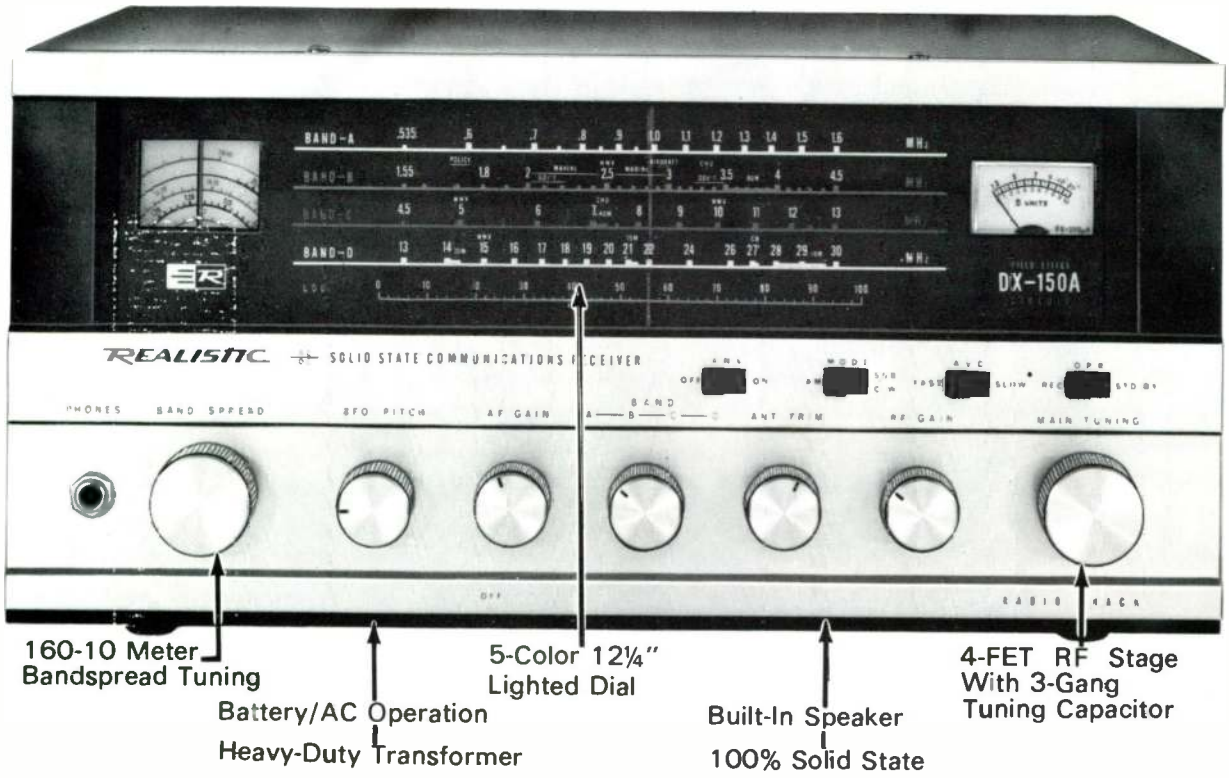

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COVER STORY

A new global system of satellite communications was formed following the launch June 14 of the latest Intelsat IV satellite over the Indian Ocean where it joined its Atlantic and Pacific brothers in a 22,300-mile-high synchronous orbit.

The successful launching of the newest satellite completes the "trilateral" positioning of Intelsat IVs over the earth's three major oceans, thereby providing members of the 83-nation Intelsat consortium with the latest system of global communications.

The giant satellite, nearly 18 feet high and 8 feet in diameter, was built by Hughes Aircraft Company, El Segundo, California, and an international team of subcontractors with a design lifetime of seven years and a capacity to handle an average of 6,000 two-way telephone calls of 12 simultaneous color TV programs, or various combinations of phone, TV, teletype and data traffic.

The new satellite, which will appear to stand still in space as its orbital speed matches the earth's rotation, will link 17 ground stations serving the Indian Ocean basin. Stations within view of the satellite are based in Lebanon, India, Indonesia, Malaysia, Kuwait, East Africa, Bahrain, Thailand, Australia, Singapore, The Philippines, Hong Kong, Japan, Spain, Italy, England and Germany.

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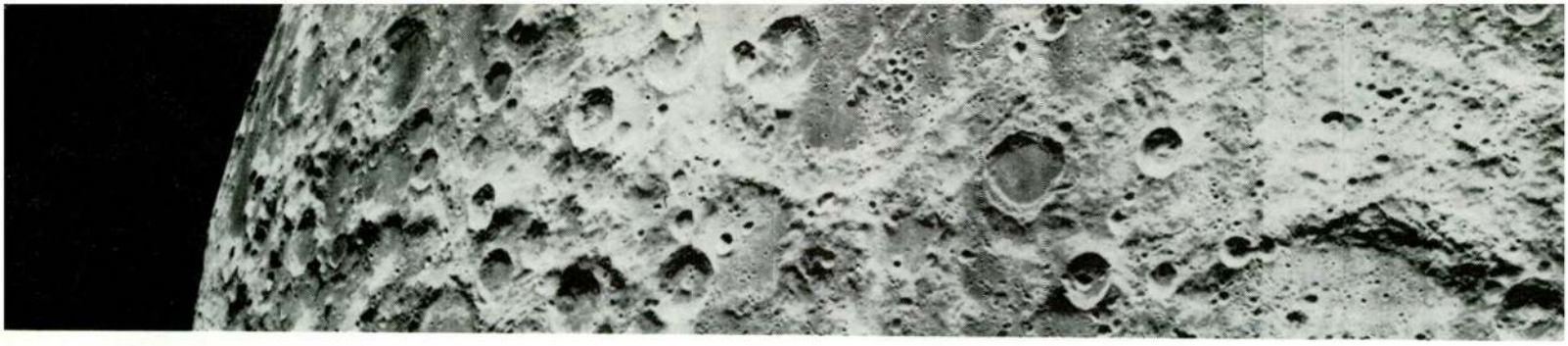
AMERICA'S MOST INFORMATIVE ELECTRONICS MAGAZINE

A TANOY CORPORATION COMPANY

Volume Six / Number One **July / August 1972**

FEATURE ARTICLES

DEPARTMENTS



Tomorrow's Astronomy: Eleven New Research Programs

"There is one central theme in the astronomy of the last seven years," reports a committee of the National Academy of Sciences – "the discovery of the existence, almost omnipresence, of a high-energy, explosive universe . . ." In the next decades, man must exploit the new technology to explore this new universe

Calling astronomy "one of the most rapidly advancing frontiers of human knowledge," the Astronomy Survey Committee of the National Academy of Sciences – after a three-year study – proposes eleven programs in their report, "Astronomy and Astrophysics for the 1970's," to "exploit fully the promising opportunities opened by advanced technologies." Of these programs, including both ground-based and space-based facilities, the Committee selected four for immediate funding and ranked them in order of importance.

The greatest need is for a *very large radio telescope array* which can break through existing observational barriers and provide an unprecedentedly clear picture of the universe at radio wavelengths. This very large array would attain resolution equivalent to that of a single radio telescope some 20 miles in diameter by using 27 antennas, deployed in a carefully calculated pattern over an area 26 miles in diameter. In addition to this large facility, which would come into operation only near the end of the seventies, the Committee suggests that smaller and less expensive radio astronomy programs and facilities be supported at research institutions.

Secondly, the Committee urges that new *electro-optical detectors* be developed and installed on all major telescopes in this country, along with television cameras, automatic controls for setting and guiding, and small computers for immediate data reduction. In addition, the Committee points out that more large telescopes are required at dark sites to compensate for the lessening effectiveness of most existing telescopes, which are increasingly hampered by the night brightness of expanding urban areas.

Support for the new field of *infrared astronomy* should be increased to include construction of a moderate-sized ground-based infrared telescope in the southern hemisphere, a large infrared telescope in the northern hemisphere, high-altitude balloon surveys, and design studies for a very large stratospheric telescope. Doubling support for this field will make it possible to study in detail the blackbody radiation of the moon and planets, cool stars, and pre-stellar clouds, as well as the background radiation of the expanding universe.

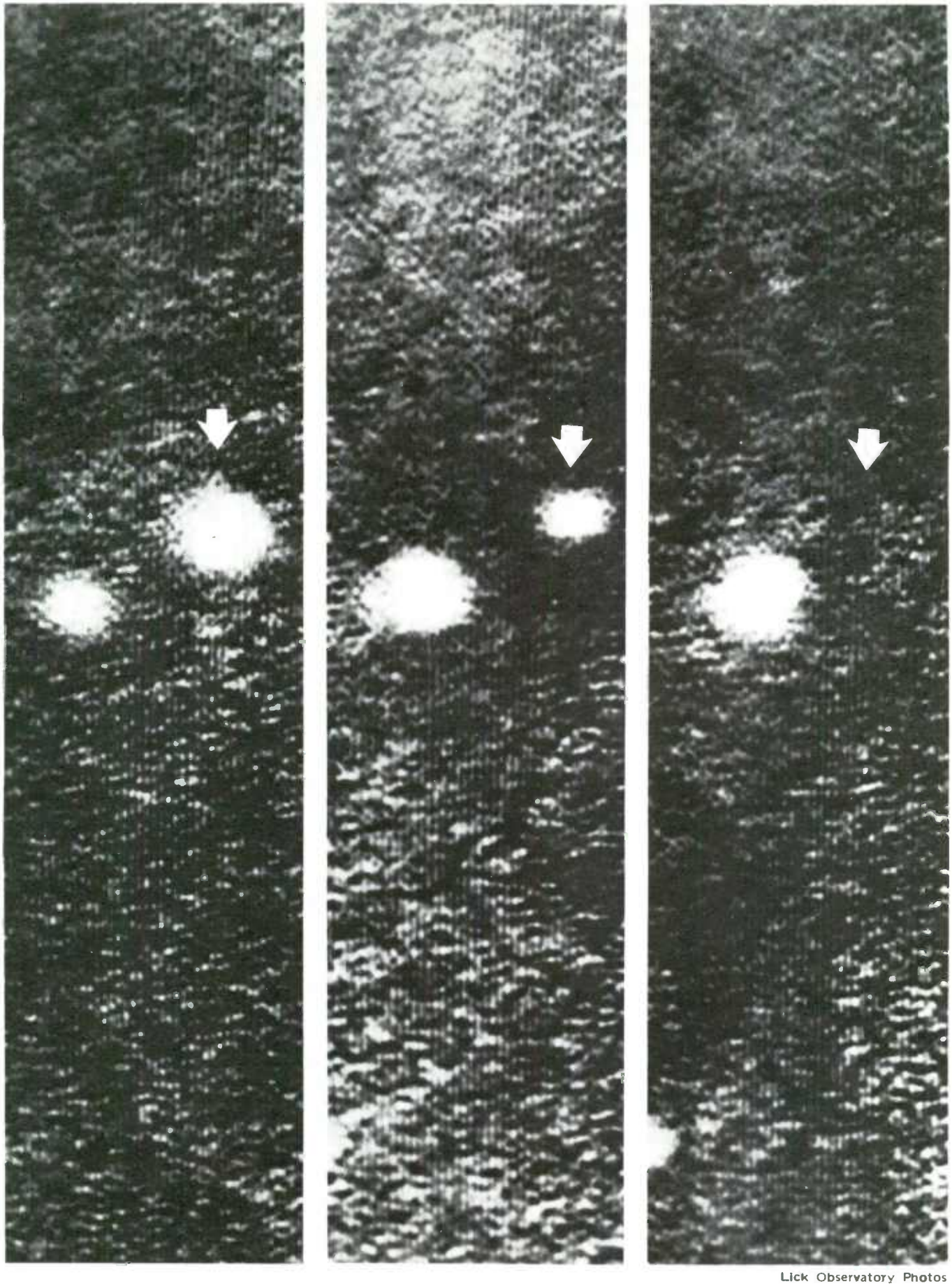
The Committee lastly recommends support for four *High Energy Astronomical Observatories* – large earth orbiters to discover and map a wide variety of the X-ray sources, in our galaxy and others, which pose "serious challenges to our understanding of high-energy astrophysics." Two of these High Energy Observatories would rotate slowly so that their instruments could scan the sky, while the other two would be pointed directly at particular objects to study them in detail.

The last seven recommended projects – viewed by the Committee as essential to a well-rounded program of astronomical research:

- Construction of a very large millimeter-wavelength antenna
- Doubling of support within three years for astrophysical observations from aircraft, balloons and rockets
- Continuation of the Orbiting Solar Observatories through OSO-L, -M. and -N
- A sizable increase in support for theoretical investigations
- An expanded program of optical space astronomy, directed toward the ultimate launch of a large space telescope
- A large, steerable radio telescope designed to operate efficiently at wavelengths of 1 cm and longer
- Construction of several modern astrometric instruments at various geographical locations.

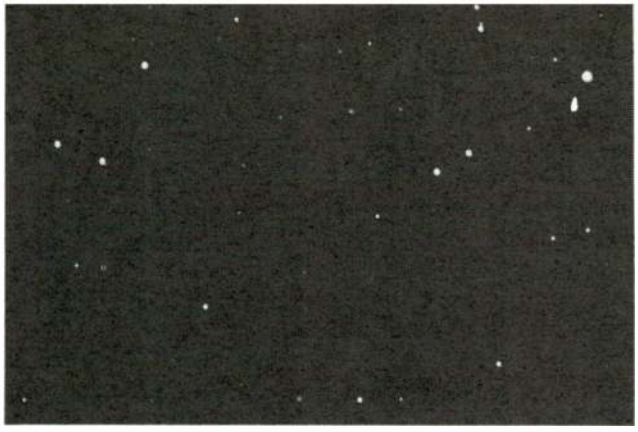
The tantalizing possibility of detecting the peoples of other worlds is reinforced, according to the Committee's report, by the development of powerful radio and optical telescopes in our era and by the use of methods in astronomical observation which are suitable for discovering signals from extraterrestrial civilizations. In addition, several of the instruments recommended by the Committee could contribute to this goal. "In the long run, detection of intelligent life elsewhere may be one of science's most im-

(Continued on page 6)



Lick Observatory Photos

What is the structure of those mysterious celestial explosions called pulsars? One of the many exciting questions for tomorrow's astronomy . . .



Photos Courtesy Westinghouse Corporation

The tantalizing possibility of detecting the peoples of other worlds is reinforced by the development of powerful radio and optical telescopes in our era. Above left photograph was taken by telescope using conventional procedure, exposure time 1½ hours. On the right is the same celestial area taken by telescope with the aid of the Westinghouse SEC tube which shows an enormous enlargement – exposure time 2 seconds. A graphic demonstration of what the new technology can mean to astrophysics.

TOMORROW'S ASTRONOMY

(Continued from page 4)

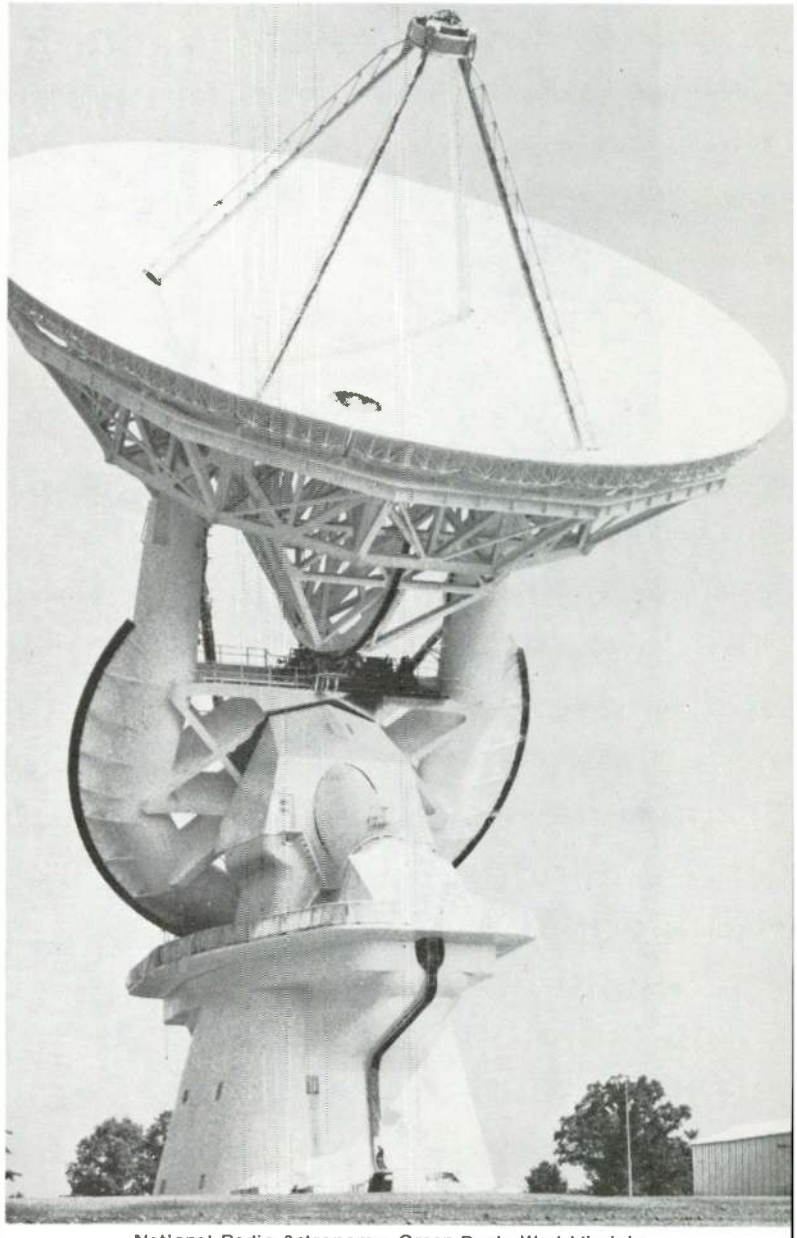
portant and most profound contributions to mankind and to our civilization."

The Committee recommends that support for these research programs be provided by a 5½ percent increase in funding over the next decade, to an average of $355. million per year. "Without such growth," the report states, "it will be virtually impossible to carry out the program of exploration on whose threshold astronomy now stands." Funding of fewer than these 11 programs would "seriously impede our efforts to capitalize on the recent past," the Committee notes. Should funding exceed current expectations, the Committee proposes a number of additional programs, the most important of which is construction and launch of a large space telescope, "possibly with manned resupply and maintenance."

The last decade in astronomical research has been an exciting one; many new questions have emerged to test man's creative genius in science: Do we live in a closed universe or an open, eternally-expanding one? What is the origin and nature of quasars? The structure of pulsars? How do planets form? Are there other planetary systems like our own? Does intelligent life exist elsewhere in the universe? "There has been at least one central theme of the last seven years, which makes it like the age of Galileo –" the Committee reports; "it is the discovery of the existence, almost omnipresence, of a high energy, explosive universe . . . Objects have been found that had not been thought of, and explanations based on new fields of physics have been advanced. We firmly expect the next decade . . . will be at least as exciting."

One final promise for tomorrow's astronomy: " . . . there will be more surprises than we contemplate and even more novel explanations of the mysterious universe into which our eyes and minds are just beginning to penetrate."

EDITOR'S NOTE: Copies of the Astronomy Survey Committee's report – "Astronomy and Astrophysics for the 1970's – are available from the Printing and Publishing Office, 2101 Constitution Avenue, N. W., Washington, D. C. 20418, at $4.75 each.



National Radio Astronomy, Green Bank, West Virginia

Shown in the above photograph is the giant 140-foot radio telescope of the National Radio Astronomy Observatory at Green Bank, West Virginia. It contains 350 tons of aluminum, 35 tons of concrete ballast, and 5 tons of balancing blocks.

New U.S.-Soviet Agreements on Science and Technology

A special report from the Executive Office of the President – Office of Science and Technology

International Relations Report

U.S. – U.S.S.R. JOINT COMMISSION

Previous U. S.-Soviet contacts in science and technology have been largely based on exchange agreements initiated in 1958 and have taken place on agency-to-agency, institution-to-institution and person-to-person levels. Now, for the first time, new joint activities will be developed, evaluated and coordinated at the executive levels of government. A recent five-year agreement establishes a U.S.-U.S.S.R. Joint Commission on Scientific and Technical Cooperation whose responsible agencies are the highest in both countries: in the U.S., the Office of Science and Technology in the Executive Office of the President; in the Soviet Union, the State Committee of the U.S.S.R. Council of Ministers for Science and Technology. The Commission's framework will be developed in the near future; the first meeting will take place sometime thereafter at an agreed time and subsequent meetings will be held at least once a year, alternating between Washington and Moscow.

Mutual benefit will be the primary basis for all joint efforts under the new agreement. Specific areas of activity have not yet been decided, but they could include the following:

- Energy research, in which each country has specified areas of expertise
- Arctic research, in which both the Soviet Union and the U.S. are expanding activities
- Management science, in which the U. S. has made significant progress which could be of value to other nations
- Atmospheric sciences, including weather modification
- Superconductivity
- Mining technology
- Marine resources

Joint activities in areas considered sensitive by either country for national security reasons are excluded from the agreement.

Both nations will attempt to facilitate such ventures as these:

- The exchange of scientists, technologists and technical information
- The development and implementation of programs and projects in both basic and applied fields of science
- Joint efforts and exchanges between research institutions and organizations
- The development of courses, symposia and conferences
- The establishment of contacts between American firms and Soviet State Enterprises, wherever a mutual interest develops
- A continuing review of possible future projects

The joint accomplishment of what neither nation is likely to undertake alone is a probable result of the new agreement, as well as the likelihood of synergistic relationships in which the combined efforts of the two parties will produce greater results than either could expect from unilateral effort.

AGREEMENT ON SPACE

As a result of negotiations in progress since October, 1970, the U. S. and the Soviet Union have agreed to cooperate in a joint test rendezvous and docking mission planned for 1975, using specially modified Apollo and Soyuz type spacecraft. It is agreed that a full project schedule will be developed and both countries will commit themselves to meeting this schedule. Training exercises will be conducted in each country for the other country's flight and ground operations crews. It is expected that, as a minimum requirement, foreign flight crews would learn the host country's language well enough to handle normal operations and respond to contingencies which might arise.

In addition to creating a new climate of cooperation between the U. S. and the Soviet Union, the agreement will have a significant domestic impact:

(1) The program would utilize about $100. million in back-up Apollo hardware which has already been constructed and which would not otherwise be used

(2) An additional Congressional appropriation of about $250. million will be needed to finance the mission and develop compatible systems

(3) The program would fill the gap in the manned American space program between the Skylab and Space Shuttle projects, and keep intact the Apollo space team and its highly-developed technological capabilities and expertise

(4) The project would stabilize many domestic jobs that might otherwise be jeopardized and create as many as 4,400 new jobs in addition to the 50,000 the Space Shuttle program is expected to generate

These two new agreements in science, technology and space exploration constitute one more step in a gradual move from confrontation to negotiation and cooperation between the two scientific and technological giants. By placing primary emphasis on the mutual benefits to be gained from cooperation, the new accords minimize the effects of otherwise conflicting demands in the different social, economic and political value systems of the two countries.

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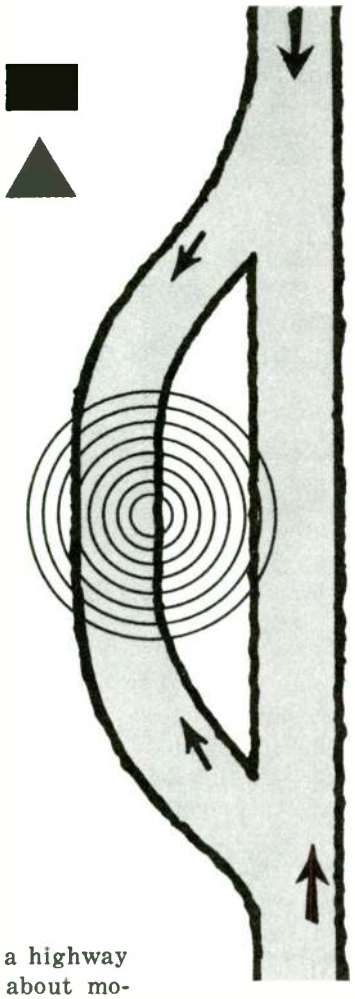
"Info-Stop" Car Radio System for Tourists

First introduced in Montana in 1969, tuning in your car radio for local information may soon be a travel feature in several other states

Lead up signs are placed on the highway shoulder to inform travelers that tourist information is available at an approaching location. If the location is on a highway rest area, the lead up sign is standard highway white on blue. On private sites, you will see the Info-Systems triangular signs.



Drawings courtesy Info-Systems, Inc.

The sign in the rest area informs the traveler the frequency to tune in on his car radio. In private rest areas, you will see Info-System triangular signs and in state owned rest areas, the white on blue rectangular sign.

You are driving along a highway in Montana, wondering about motel accommodations in an unfamiliar area. Then you notice a white-on-blue rectangular highway sign that tells you a public rest area with "Info-Stop" facilities is ahead. You pull into this rest area, where another white-on-blue sign gives you the frequency to tune your car radio to for that area. In a ten-minute "Info-Stop" message you find out not only what motels you may choose from for the night—locations, prices and facilities offered, but about other local commercial services, activities, scenic and recreational attractions and their historical significance. You miss something important in the first broadcast; but the "Info-Stop" message is repeated continuously during the daylight hours, so nothing is lost. Feeling less a stranger to the region, you continue on your way.

This scene has been played many times in Montana since the "Info-Stop" System was introduced there in 1969. Chances are good that motorists in several other states will be offered this service in the near future. Aside from the advantages of providing instant tourist information, the use of the system would mean a decline in highway billboards and less visual distraction — hence, greater safety — for the motorist.

"Info-Stop" is a low-power, short-range (about four-tenths of a mile) AM radio station operating on a 500 to 1600 frequency, which is below FCC limitation and does not interfere with commercial radio. It operates on 110 volts AC or 12 volts DC and can be programmed from a live microphone or from recorded tape. Multiple unit transmitters can extend range for many miles. The "Info" concept is expanding daily: its use for traffic control, closed-circuit radio for tourist information in large hotels, ski information, and related services—is being rapidly developed. A small but versatile system may introduce a new perspective in instant communications.

NEWS ORBIT AROUND THE WORLD OF ELECTRONICS

OCEANOLOGY

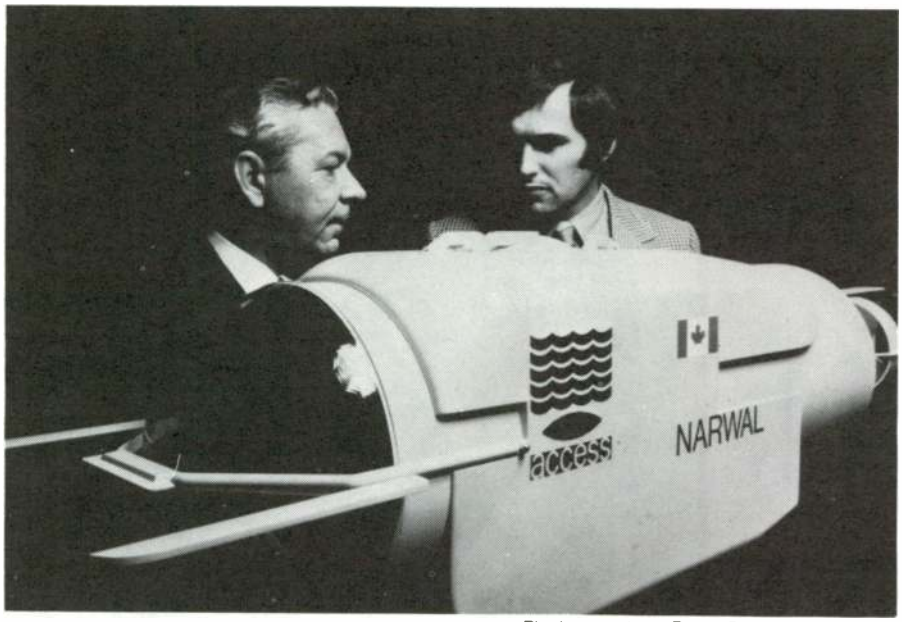


Photo courtesy Perry Submersibles Ltd.

A MODEL OF THE TRANSPARENT-NOSED SUBMERSIBLE PS-1 NARWAL is being examined by Peter A. Broadhurst (right), president of Perry Submersibles Ltd., and Woodford M. Rand, vice president.

"Modular" sub opens new era

Construction has begun on a "modular" submarine designed specifically to perform under-ice geophysical and geological surveys for gas and petroleum. The submarine, called PS-1 NARWAL, incorporates features never before used on a submarine and its use may open a new era in Arctic offshore operations. NARWAL is being built by Perry Submersibles Limited at Mississauga, Ontario, for ACCESS, a Canadian ocean services company. PSL is an associated firm of Perry Oceanographics, Inc., of Riviera Beach, Florida.

The 9,400-pound prototype submersible will have a large, hinged, transparent nose providing both maximum observation and easy maintenance of the sub's equipment. Nickel cadmium batteries will give her a 15-mile operating range, cruising at two knots, plus a 50 per cent power reserve. A unique, dual-motor propulsion system will give NARWAL extra reliability for under-ice operations. Under the unique construction concept, entire flanged hull sections can be unbolted, removed and instrumented for special mission requirements or replaced with lockout or special propulsion modules. Peter A. Broadhurst, managing director of Perry Submersibles Limited, believes the modular concept will avert obsolescence of submersibles as advances are made in propulsion and other technologies.

ACCESS has also contracted with PSL to build another submarine featuring modular construction: PS-2, to be used for more conventional offshore commercial and scientific missions. The six-ton vessel, to be completed in time for August 1972 operational commitments, will incorporate the same large, transparent nose and a removable conning tower with nine viewports. Mechanical arms will enable the taking of geological samples and recovery of objects from the sea bottom. PS-2 will have dual external pods carrying batteries on quick-change trays.

The two submersibles will be American Bureau of Shipping Classified for a 1,025-foot operational depth. Several of their design features have been proven on the Perry (USA) PC-8 submarine, which completed a highly successful charter in Canadian waters last summer.

Operation of the submarines will expand Canada's ocean efforts into an exciting new area of industrial development, according to Broadhurst. "Introducing the use of submersibles," he says, "recognizes the importance of developing Canada's own under-water technology, particularly in the Arctic, where exploitation of the vast supplies of natural resources is so essential to industry and Canadian sovereignty."

While initially concentrating on work in Canadian waters, ACCESS will offer its services in other Continental Shelf areas and inland waters of the world.

SPACE

800,000-mile Jupiter shots

Details of the planet Jupiter never before seen are expected to be photographed by a scientific instrument developed for the Pioneer F spacecraft's two-year journey to the largest planet. An imaging photopolarimeter will shoot color "close-ups" from "only" 800,000 miles from Jupiter, improving on shots Earth telescopes get from their 367-million-mile shortest distance, reports Robert F. Hummer, manager of electro-optical instrumentation at Santa Barbara Research Center, a subsidiary of Hughes Aircraft Company. The device — referred to as IPP — was designed and made for the Jupiter project, along with an infrared radiometer to probe the mysteries of Jupiter's heat radiation. Project contracts from NASA's Ames Research Center, Mountain View, California, totalled $3.8 million.

(Continued on next page)

"The IPP weighs 9½ pounds and the radiometer 4½ pounds," Hummer says. "But when you are dealing with deep space probes, getting the maximum scientific package down to the minimum size and weight is an incomparable challenge. The job took the best talent of the Hughes center two years because of the unique technical difficulties it presented: the instruments must perform complex functions for an unusually long time, on an extremely limited power and weight budget, and through a hazardous radiation environment." Radiation belts of Jupiter are estimated to be 1 million times more intense than Earth's Van Allen radiation belts.

The IPP will measure brightness and polarization of zodiacal light (sunlight scattered by interplanetary dust and solid matter) to determine the amount and character of interplanetary solid material and will seek information on the structure and composition of Jupiter's clouds and the amount and nature of atmospheric gas above them. The IPP will take 10 pictures of the planet in the last 20 hours before its closest approach, starting when it is 800,000 miles away. Pictures will be taken from viewing angles impossible from Earth, hopefully revealing for the first time shadowing effects on the planet.

"Jupiter is a unique planet in that it radiates more energy than it receives from the sun, thus behaving something like a small star," Hummer says. "It is hoped the radiometer will confirm whether Jupiter does in fact have its own internal energy source." The instrument will seek hot spots in Jupiter's outer atmosphere and map temperature distribution. This may help explain phenomena like the "hot shadows" of Jupiter's moon and the planet's Great Red Spot, an oval 30,000 miles by 8,000 miles, appearing occasionally in its southern atmosphere. Jupiter's equatorial diameter is 88,000 miles, about 11 times that of Earth. The radiometer will also measure cold areas (including Jupiter's dark side and its polar cap—perhaps confirming the belief of many scientists that the cap is composed of frozen methane) and investigate the relative abundance of helium and hydrogen on the planet.

Team bid for Venus mission

Hughes Aircraft Company announced formation of a management and technical team with General Electric Company to compete for the definition phase of a planned series of missions proposed by the National Aeronautics and Space Administration to explore Venus with Pioneer-class spacecraft. NASA program management will be under the direction of Ames Research Center at Moffett Field, California.

Advantages of the group effort? "The team will bring to bear the highly successful spin-stabilized spacecraft technology developed by Hughes in the past decade, and the extensive experience of re-entry technology developed by General Electric," says Hughes space and communications group vice-president, Dr. Albert D. Wheelon.

The objective of the Venus Pioneer program is to gather detailed information about Venus' atmosphere. Missions will include both orbiter and atmospheric probes, beginning with multiple probe missions at the December 1976 to January 1977 Venus "opportunity." By comparing the atmospheres of Venus, Mars and Earth, scientists hope to construct a better model of Earth's atmosphere for use in predicting long-term changes in climate as well as short-term effects caused by environmental contamination.

5-year outer space computer

A computer that can stay healthy and on the job for five years in outer space is the object of a design study now underway at Hughes Aircraft Company's ground systems group. The spaceborne computer, called ARMMS—for Automatically Reconfigurable Modular Multiprocessor System, must be adaptable to missions ranging from manned launch vehicles and unmanned interplanetary spacecraft, to large manned earth or lunar orbital stations, reports Dr. Norman Enenstein, manager of Hughes' data processing products division. The 18-month project will be accomplished under the

(Continued on page 31)

"Shoot and Scoot" – New TV-Guided Missile Goes It Alone

A miniature TV camera in the Maverick missile's nose-cone zeroes in on target – while the pilot veers away to safety

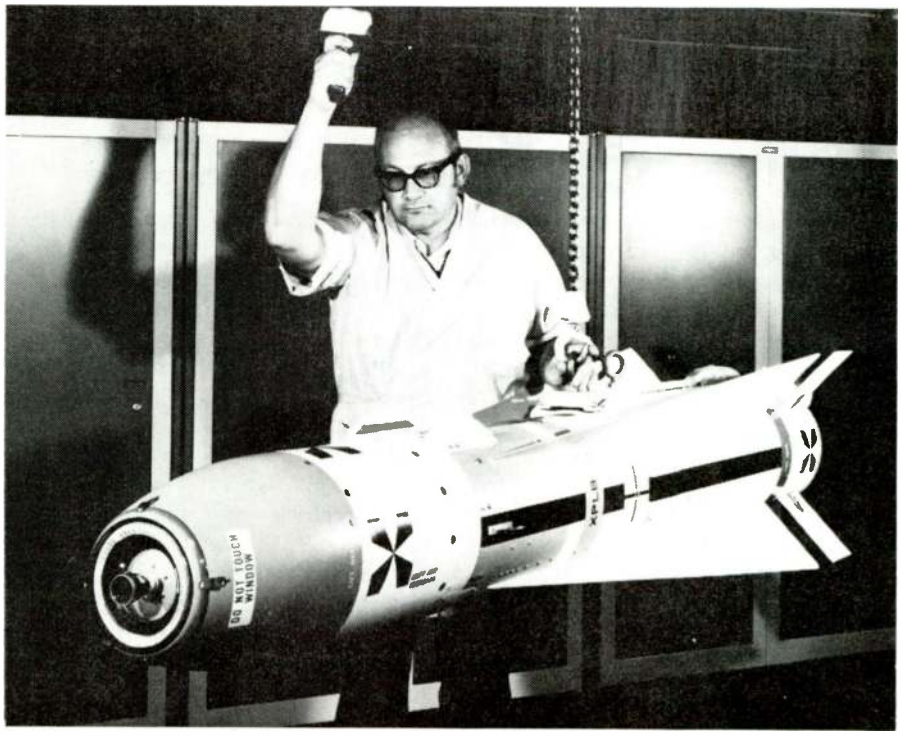
Special Military Report

The U. S. Air Force's new TV-guided Maverick missile — developed by Hughes Aircraft—enables a pilot to launch and immediately leave the area, while the missile independently steers itself to the target. This "shoot and scoot" capability is provided by a miniature TV camera in the missile's nose-cone that homes in on a target the way a television camera zooms in for a close-up of sports action. The camera is focused on a target by the pilot and locked on with the press of a button. After launch, the Maverick's "eye" remains fixed on the target, automatically guiding the missile to impact on the precise spot at which the TV camera is looking. Meanwhile, the pilot is free to attack other targets—a fighter aircraft can carry six Mavericks for launching at several different targets on a single pass — or escape safely from the air vicinity. The Maverick missile is 97 inches long, with a 12-inch diameter and a 28-inch wing span; it weighs less than 500 pounds and carries a warhead with a conical-shaped charge designed for high penetration.

In recently completed flight tests the Maverick scored hits on a variety of targets at an unusually high success rate for a missile still in development. Its accuracy and the varied conditions under which the tests were flown show that the new missile will be particularly effective in the kind of ground support missions the Air Force frequently flies. The Maverick is expected to provide a dramatic increase in the strike capability of aircraft against such hard-point targets as field fortifications, radar sites, buildings, tanks and armored vehicles. "We are learning," said Hughes vice-president John W. Black, "that the Maverick can hit just about anything its TV camera can see. It has scored direct hits in situations where no other missile would be effective." One of the reasons for the high reliability of the Maverick, according to Black—and for its ahead-of-schedule production at a lower cost than originally projected—is that the design philosophy from the beginning of the program has been to use proven, existing techniques and components, instead of developing new technology that might delay the program.

Photos Courtesy Hughes Aircraft Company

Above, a television camera lens protrudes from the nose-cone (white circle, lower center) of the newly-developed Maverick missile, which will enable a pilot to "shoot and scoot." Below, Hughes technician Earle McCord hoists a Maverick on a chain-pulley. During developmental flight tests, the Maverick scored better than 90 percent success rate.



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Edited by
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- HISTORY OF INVENTION
- PICTORIAL HISTORY OF ELECTRONICS
- OLD-TIME RADIO PROJECTS
- NEWS OF HISTORICAL INTEREST

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—From History of Civilization
by E. A. Allen
Published in 1891, by Central Publishing House, Cincinnati, Ohio

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BIOGRAPHICAL SKETCHES OF GREAT MEN IN ELECTRONICS

Joseph Tykocinski Tykociner

October 5, 1877 — June 12, 1969

Electrical Engineer, Inventor, Educator

by William M. Palmer

Let us honor our men of science
Who once walked upon the planet Earth
Along the uncharted trails of electronics
In search of a better way of life
For all mankind

Today's growing ethnic consciousness, although often billed as humanitarian in objectives, has the insidious effect of setting up tiny self-seeking nations within our nation.

When our forefathers came to America they gladly cast off the ties that bound them to their mother country, and they merged their knowledge and resources with that of settlers of many national origins to achieve the common aim . . . a new nation founded upon individual freedom . . . and the opportunity for all to climb the highest mountain of achievement. They believed in working together for the common good.

Out of this heritage came men like Alexander Graham Bell, Michael Pupin, Nikola Tesla, Charles Steinmetz, David Sarnoff, Vladimir Zworykin . . . and countless others including the subject of this biographical sketch, Joseph Tykocinski Tykociner (Joe-seff Tick-oh-shin-sky Tick-oh-shiner).

Tykociner was born in Vloclavek, Poland, on October 5, 1877. A hundred years before that, another great Polish friend of America, during the Revolution, Count Casimir Pulaski, was distinguishing himself at the battle of Brandywine as a soldier in the army of General George Washington. Count Pulaski fell mortally wounded during the siege of Savannah (Georgia) and died on October 11, 1779.

In recognition of his valor, a famous early-day fort was named for him, Fort Pulaski, on Cockspur Island at the mouth of the Savannah River, 17 miles east of Savannah, Georgia. Today, it is a part of the U. S. National Park System which is dedicated to conserving the scenic, scientific, and historic heritage of the United States.

Unfortunately, the shifting sands of destiny erased the path to recognition for another great man of Polish ancestry, the subject of our biographical sketch, Joseph Tykociner, who has been called "a man ahead of his time."

Tykociner experienced the same skepticism faced by many other inventors when mankind examines new ideas and innovations which portend changes in his traditional environment. It was in this intellectual atmosphere that Tykociner demonstrated his dream of a quarter century, the recording of sound electrically on the same film carrying motion pictures.

Tykociner's device was built around the principle of producing sound by passing a ray of light through a sound track of the film into a special light-sensitive tube converting it into a fluctuating electric current which could drive a telephone receiver or speaker. Its outstanding feature was the recording of the sound on film photographically, instead of the less efficient mechanical method of making recordings.

Sadly, his work with sound-on-film came almost a decade too soon. One of the motion picture leaders of that era declared that the inventor's sound pictures were not practical. He went on to explain that movies were an illusion of sound and that if one were to combine the two illusions simultaneously it would produce a trauma greater than the human mind could bear. "The public won't accept it," he finalized. So Joseph Tykociner never profited from his sound-on-film invention the credit for which some years later went to other men.

Tykociner's historic demonstration of the first sound-on-film movies was made the evening of June 9, 1922, at a meeting of the Urbana (Illinois) Section of the American Institute of Electrical Engineers which was held at the University of Illinois. The demonstration included a violin player, Mrs. Tykociner,

(Continued on page 16)

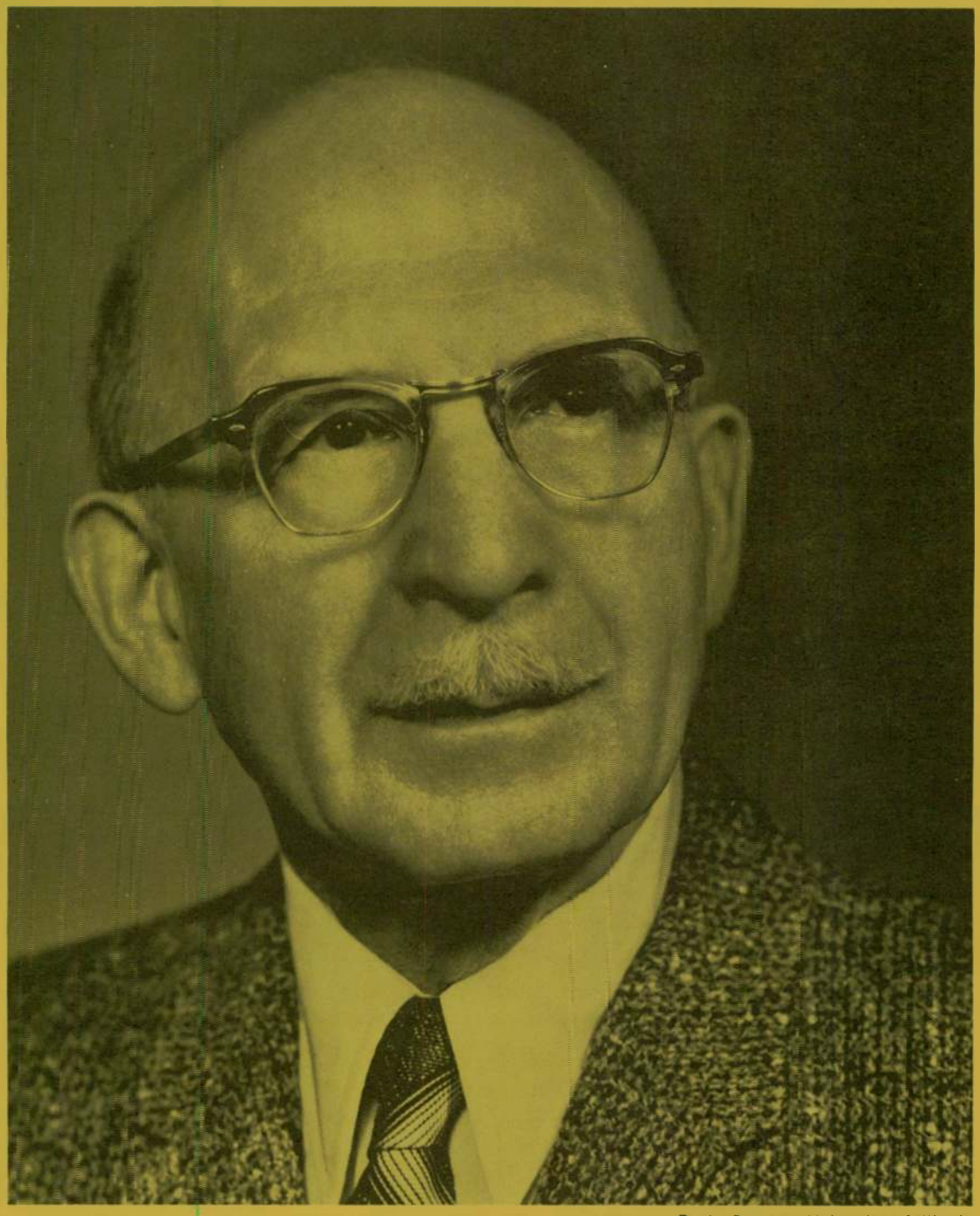


Photo Courtesy University of Illinois

Joseph Tykocinski Tykociner

October 5, 1877 — June 12, 1969

Electrical Engineer, Inventor, Educator

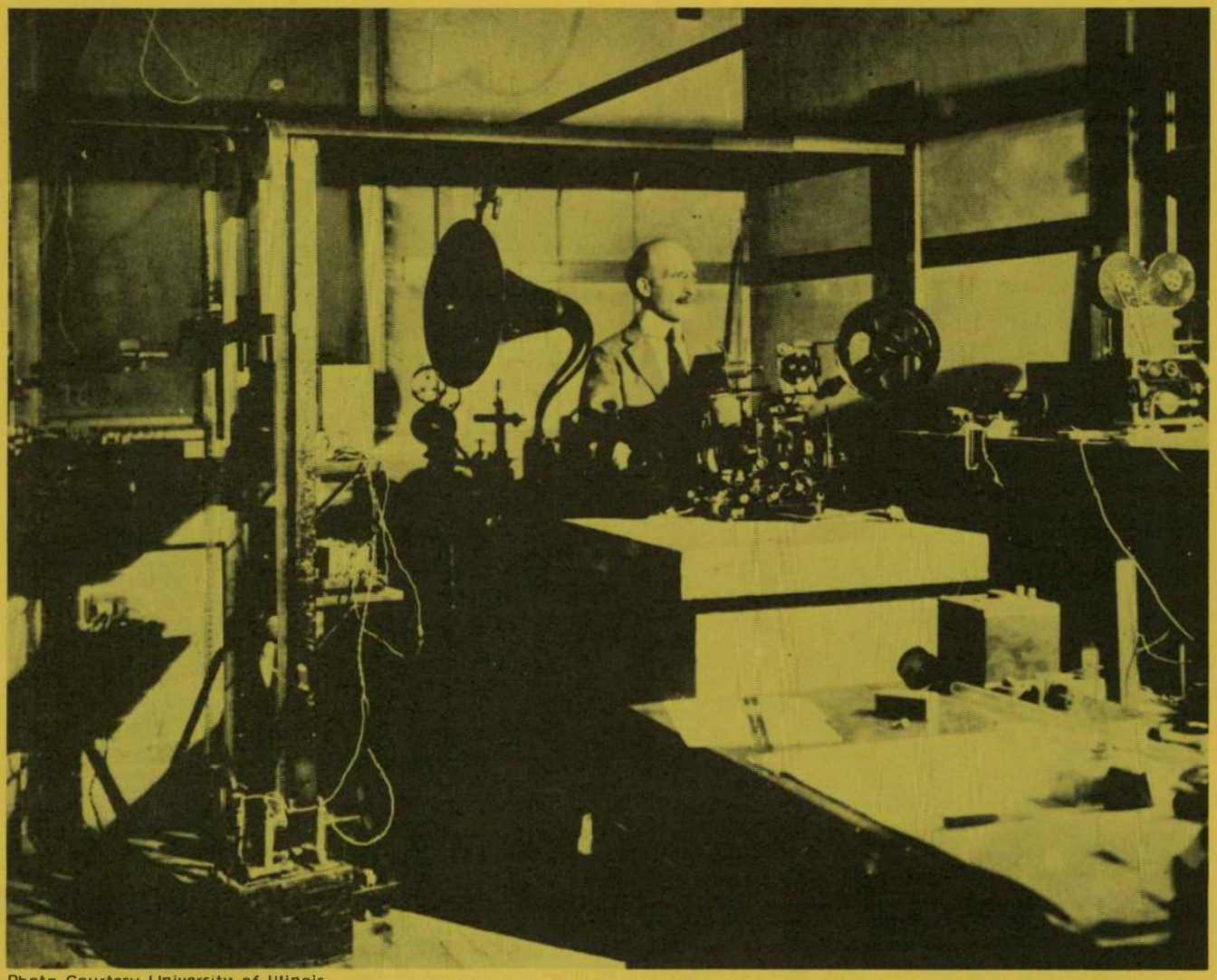


Photo Courtesy University of Illinois

This old photograph shows Joseph Tykociner at work in his laboratory at the University of Illinois at Urbana. He produced a variable-density sound track beside the picture images on the film, the principle that is used in motion pictures today. The inventor's wife was the first woman to "star" in talking pictures. With a small bell in her hand, she said, "I will ring the bell." The action plus sound amazed spectators.

JOSEPH TYKOCINER

(Continued from page 14)

who rang a hand bell, and Professor Ellery B. Paine, then head of the University's electrical engineering department, who recited Lincoln's famous Gettysburg Address. It was the crowning achievement of Tykociner, who had come to the faculty in 1921 after a brilliant career in Europe in the new field of wireless communications.

On July 30, 1922, the *New York World* devoted a half-page to Tykociner's futuristic invention. He forecast a revolution in the movies. "Many noted plays, comedies, and farces that are not now adapted to the screen, because of the wit, humor of the dialogue, and personality of the actors, may be revived and find new favor," he predicted. "I have great hopes that it will cause a revival of the masterpieces of dramatic art," he said. Today, we know just how accurate was the prediction of this great man of vision . . . who saw beyond the horizon a world several decades away.

Tykociner, who conceived the idea of sound-on-film recording during a voyage from Antwerp to America in 1896, was graduated from Higher Technical Institute at Coethen in 1901, and studied in Berlin and Goetlingen, Germany. He joined the Marconi Wireless Telegraph Company in England as a junior engineer. Two years later he joined the staff of the Telefunken Company in Berlin as a research engineer. In 1904, Tykociner was offered a responsible position in Russia, and during the ensuing fourteen years made the Russian navy the first fleet completely equipped with wireless. After World War I when Poland was reborn, Tykociner set up the nation's first wireless communications system.

In 1920, Tykociner came to America to stay. After a year's work at the Westinghouse Electric and Manufacturing Company's research laboratory, he accepted a position with the experiment station of the University of Illinois. At the U. of I. he pioneered in both radio and other electronic fields.

In 1929, he became a professor in the Graduate College. He retired with the rank of professor emeritus in 1949. His scientific investigations included, besides sound-on-film motion pictures, high-frequency measurements, dielectrics, piezoelectricity, photo-electric tubes, and microwaves. He was a fellow of the American Physical Society and the American Society for the Advancement

(Continued on next page)

of Science.

According to information from the U. of I., admirers of Tykociner recently had a copy made of the original film used in the world's first sound-on-film demonstration, and also a 16-millimeter copy of the film properly adjusted for use in modern projectors. The bit of sound track, usable after a half-century, was stripped into place on the special film for a commemorative showing on the 50th anniversary of sound-on-film movies which was held May 1, 1972, in the Lincoln Hall theater on the U. of I. campus. The distinguished speaker for the occasion was the 1971 Nobel Prize recipient in physics, Dennis Gabor, of the faculty of Imperial College, London.

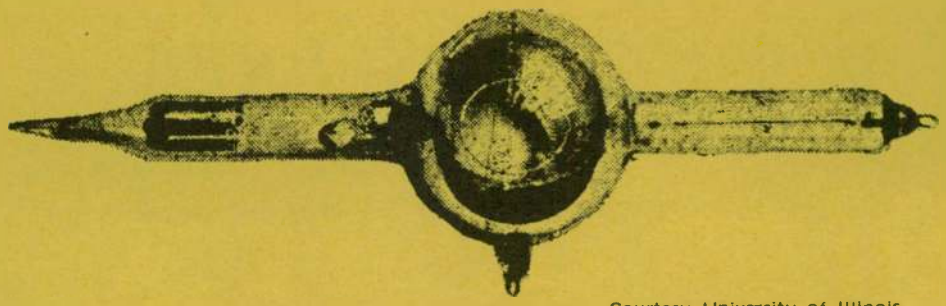
In the sunset years of his life, Tykociner devoted much of his time to development of a new science, which he called Zetetics. He published his first book on the subject in 1959. His enthusiasm for this new and broader field of science brought him out of retirement to teach the subject from 1962 to his last year. He is thought to have considered it his greatest contribution.

Zetetics, in contrast to the specialization in most sciences, encompasses the whole of human knowledge and culture – the arts, sciences, humanities, and engineering. It classifies all knowledge and examines interrelations to seek out the gaps; and it studies the mental processes involved in research, as well as environmental factors which facilitate research. It attempts to present a view of the total knowledge and its relations.

Joseph Tykocinski Tykociner, an American, died June 12, 1969, just a few months before his ninety-second birthday.

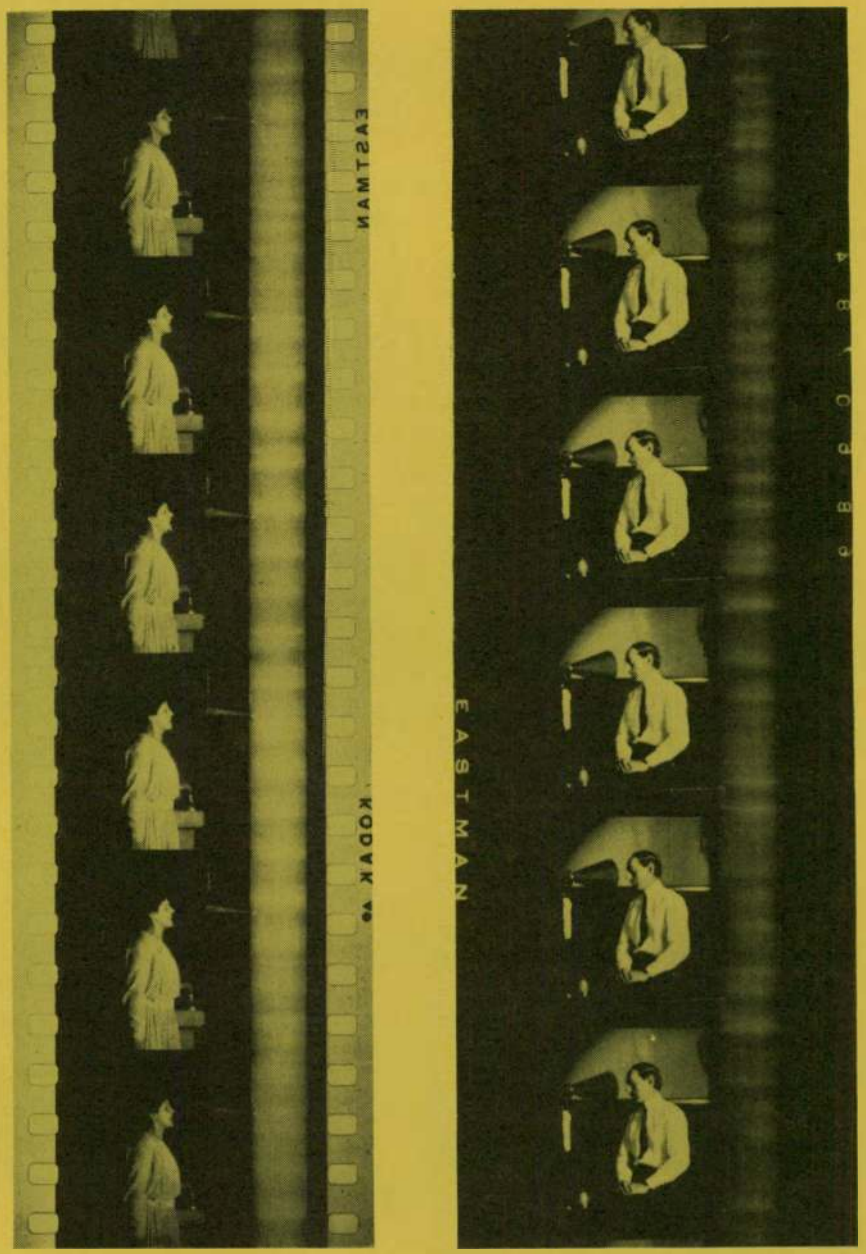
Through the pages of *History's Hall of Honor, Electronics Digest* endeavors to give recognition to great men of many national origins who have made outstanding technological contributions in the field of electricity/electronics, and who have shared in the building of America.

We are proud of our men of science, and we are proud to play even a small part in the commemoration of the 50th anniversary of the first sound-on-film demonstration, the invention of an American of Polish ancestry, whose will to achieve, whose vision and knowledge left its mark in mankind's unceasing quest for a better way of life.



Courtesy University of Illinois

This is a picture of the crude light-sensitive tube used by Professor Joseph Tykociner in his sound-on-film apparatus. It was a type which had been perfected by another University of Illinois professor, Jacob Kunz. The tube enabled Tykociner to complete his dream of a quarter century . . . the wedding of action and sound.



Courtesy University of Illinois

These photos show a portion of the history-making film strips produced by Professor Tykociner and used in his successful demonstration of the first sound-on-film motion picture on June 9, 1922. Mrs. Tykociner spoke a few lines and rang a bell, and Professor Ellery B. Paine, then head of the electrical engineering department, recited Lincoln's famous Gettysburg Address. It was a great moment in history, although it has not received, for the most part, due recognition down through the years.

yesterday & today

NEWS OF HISTORICAL INTEREST

The New England Wireless Museum

Today the word "museum" has a much different meaning than it did some years ago. In past times it suggested a rather drear atmosphere with (usually) a poorly-presented collection of objects. The modern museum is, by contrast, a bright place where exhibits can be handled, operated and explored.

Behind the Revolutionary home of the Merriam family in East Greenwich, Rhode Island, the first all-radio museum in this country has come to completion. It is a fitting location for this hall of electronic history: the Merriam family has been prominent in engineering for many generations, and Robert Merriam —the museum's developer—is today actively involved in the radio marine field.

A rather modern sheep barn was available for use and in 1962 alterations were started to house a growing collection of old radio gear. When the evidences of "neat stock" had been removed, the interior finishing of the barn took on a very different appearance. The building is divided lengthwise into three parts. The north section starts with early 1900 and World War I items—to the 30's—with broadcast receivers and early TV equipment. In a five by eight foot alcove is an exact ship radio shack of about 1920, complete with receiver, main and emergency spark transmitters, and lighted by a standard ship porthole and a wall kerosene lamp.

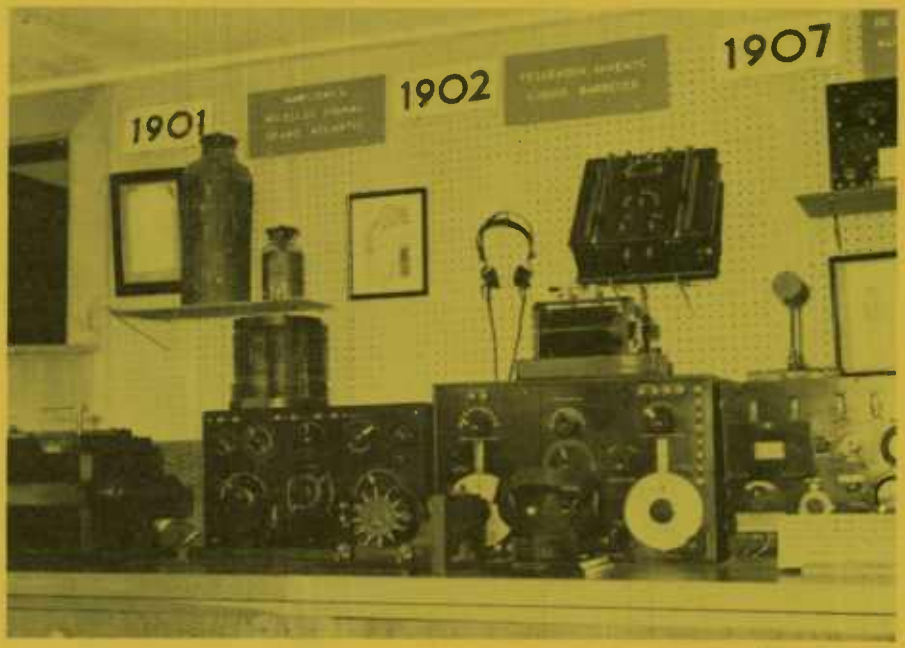


Photo courtesy New England Wireless Museum

Start of early apparatus display — north corridor.

New England Wireless Museum Building — four-wire antenna overhead.

New England Wireless Museum

The center corridor shows cased displays of component parts such as crystal detectors, tuning units, head phones, coherers, and all the early devices of a past era. On the wall opposite are pictured all the pioneers of the world of radio and the age of electric invention. Included in this grouping of personalities are early and prominent "hams," since the start of radio was a boys' game—and many of the boys of this era were the inventors of devices and techniques we use today.

The museum's librarian—Mrs. Nancy A. Merriam—has collected a fine and remarkable array of technical books on the subject of electricity and wireless. And who would have thought that books written for youngsters — like "The Boys of the Wireless" and "The Radio Boys in Darkest Africa" — would be as eagerly sought after today as the treatises by early radio engineers!

In October 1964 a national meeting of the Antique Wireless Association was held at the Museum and Governor Chaffee of Rhode Island officiated at its formal dedication. The radio sciences have grown so rapidly that the Museum at present shows only a period up to the last war. The development during World War II of radar and specialized gear resulted in an overwhelming array of radio equipment. The Museum hopes to acquire some of the most significant items from this period, but a complete representation would

(Continued on next page)

Photo courtesy New England Wireless Museum

Bob Merriam listening to 500 KC on ship shack display receiver.

WIRELESS MUSEUM
(Continued from preceding page)

be impossible. The Museum feels, however, that the beginning years of any venture have the greatest charm—and it offers the public a very special thrill: the reliving of that day they heard their first signal when the sensitive spot on the crystal was located! Time retreats to 1900 with the sound of a rotary spark gap and sights of early radio receivers.

Directions: west of Route 2 on Frenchtown Road (next to the Bostich Staple plant), proceed to the intersection with Tillinghast Road and turn south. From that point the masts of the Wireless Museum will easily be visible. The Museum is not open on a regular schedule, but its proximity to the owner's home insures access during the week. If any group wishes to make a special visit, they are advised to call ahead (East Greenwich, Rhode Island: TU 4-1710).

During the past two years a bonus has been added to the museum complex—a new building has been constructed to house a unique collection of old steam engines. There will be a special dedicatory ceremony for this new museum on August 19th of this year. Anyone interested in steam engine history is invited to attend this event. Although there will not be any special activity in the Wireless Museum on this occasion, it will be open for inspection by interested visitors.

Classified ads to be accepted

Beginning with the September/October issue, *Electronics Digest* will accept a limited number of classified ads from our readers who are collectors of antique radio equipment, as a "Shop and Swap" convenience. All ads, of course, must be related to the buying, selling or swapping of antique radio items. The cost of the ads will be: $1.90 per line (seven words), with a 3 line minimum. If interested, write for information: Electronics Digest, Dept. HCA, P. O. Box 9108, Fort Worth, TX 76107.

50th anniversary of sound-on-film

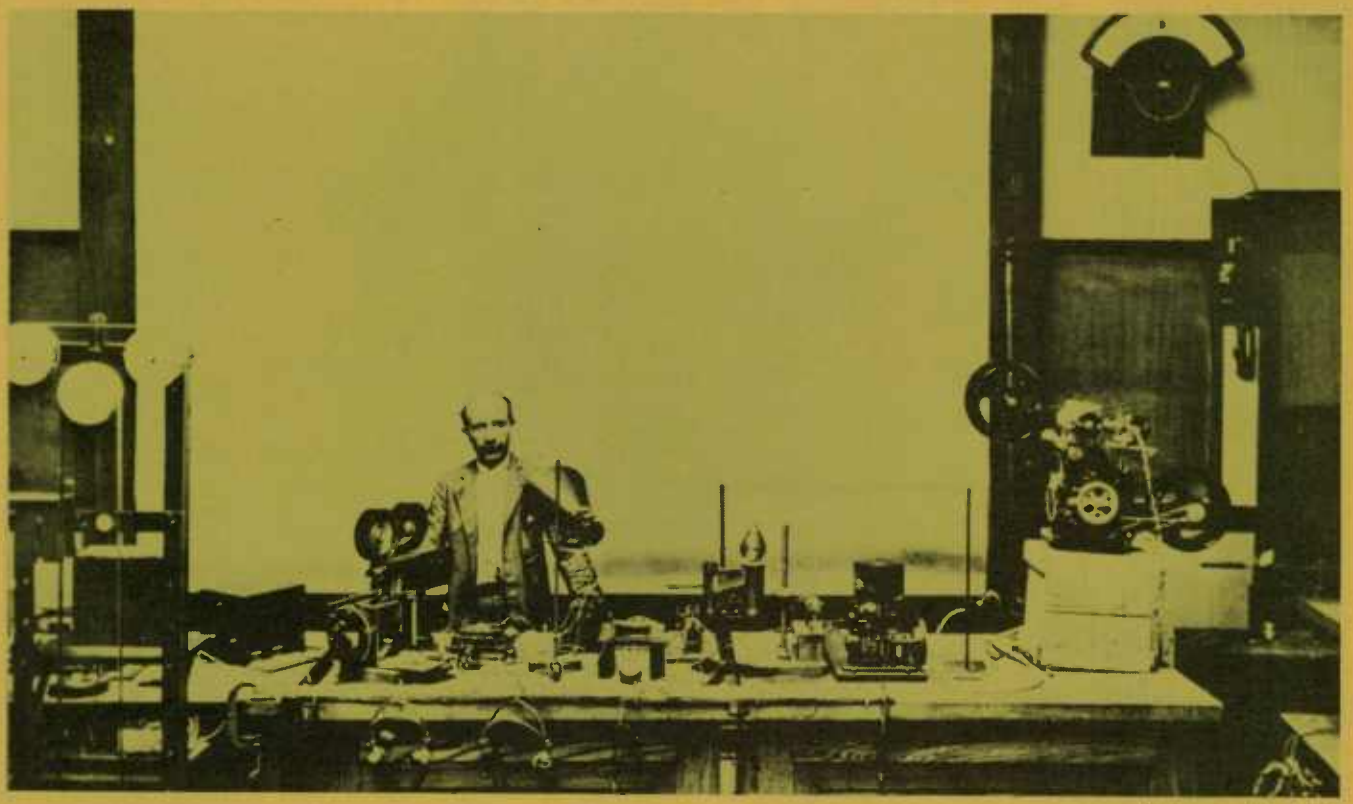
A name that is seldom mentioned in the history of sound-on-film motion pictures is that of the late Joseph Tykocinski Tykociner, a professor of electrical engineering at the University of Illinois for more than 28 years.

He spent many years developing a sound-on-film apparatus so revolutionary that after its successful demonstration on June 9, 1922, a motion picture leader of that era called the invention impractical. The illusion of both sound and motion in pictures was also declared a combination quite possibly beyond the endurance of the human mind. Tykociner could find no one interested in commercial application of the invention in the movie industry.

As with all fields of scientific interest there were others who followed Tykociner with research and development along the same lines, and it was they who eventually profited from the sound-on-film concept, and were given credit for its invention. As it was then, so it is today, that so many of our national leaders in business and government lack vision with which to look beyond today . . . to behold the breadth and depth of the future.

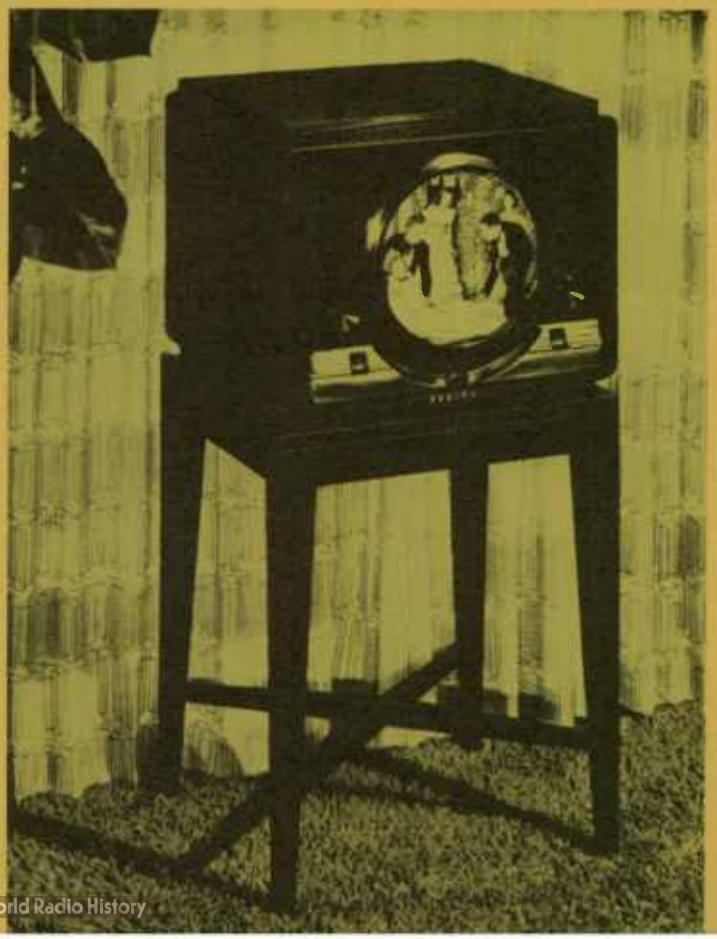
The 50th anniversary of sound-on-film, as produced by Joseph Tykociner, was celebrated at the Lincoln Hall theater on the University of Illinois campus, on May 1, 1972.

FROM AN ALBUM®



Courtesy University of Illinois

This old photograph shows Professor Joseph Tykociner at work in his laboratory on the campus of the University of Illinois at Urbana. It was in the Physic Laboratory at U. of I. that Tykociner successfully demonstrated the world's first sound-on-film motion pictures on June 9, 1922. The motion picture industry at that time could see no practical use for his invention. One of their leaders of that era emphatically declared, "The public won't accept it." This year, 1972, marks the 50th anniversary of sound-on-film, and was celebrated at the University by showing a portion of the original sound track, still good after all these years.



Three decades have passed since television first made its debut in the consumer market in the United States on a practical scale. Today, not many homes in America are without a television set – many homes have a color television set. Even a considerable number of citizens classed as poor, by today's American yardstick of poverty, own a television set, an automobile, have a telephone, and other items of an affluent society. It is a way of life only dreamed of by people in most parts of the world. But in the end, only a productive society can sustain it. The television set (right) was Zenith Radio Corporation's first television set, a black-and-white model of the year 1948.

Licensed under Armstrong U. S. Patent No. 1,113,149.

MacMillan Listens to Honolulu and New Zealand "Tunes In" California

Using ZENITH TRADE MARK Long-Distance Radio

From a little ice-bound schooner—eleven degrees from the North Pole—comes this message:

"Am very thankful that Arctic Exploring Ship Bowdoin is equipped with complete Zenith radio apparatus. Here at top of world, in darkness of great Arctic night, we have already listened to stations practically all over United States, from Europe, and even from far away Honolulu. Zenith has united the ends of the earth."

—"MacMillan"

Again, from far-off New Zealand comes a report of radio reception even more startling:

"It may interest you to know that the writer last evening landed KGO, Oakland, California, between 6:45 and 7:30 P. M. Heard his call four or five times distinctly, and jazz music. The music was not as clear as the voice, but one could pick up the tune all right. As San Francisco is ***6,300 miles from New Plymouth***, and only one tube was used, we think this is a very fair performance."

—(signed) H. Charles Collier.

The sets used by Captain MacMillan and Mr. Collier are earlier models—since improved by the addition of ***a third stage of audio frequency***. These new models, described at the right, represent an achievement in radio construction not duplicated in any other set on the market. A demonstration will convince you.

Write today for full particulars and name of nearest dealer.

Zenith Radio Corporation

McCORMICK BUILDING, CHICAGO

Model 3R The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the new and different Zenith three-circuit regenerative tuner.

Fine vernier adjustments — in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit — make possible extreme selectivity.

The new Zenith 3R has broken all records, even those set by its famous predecessors of the Zenith line. Under favorable conditions, satisfactory reception over distances of 2,000 to 3,000 miles, and over, is often accomplished in full volume, using ***any ordinary load-speaker***. The Model 3R is compact, graceful in line, and built in a highly finished mahogany cabinet..... $160

Model 4R The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the new Zenith regenerative circuit in combination with an ***aadion detector*** and ***three-stage*** audio-frequency amplifier, all in one cabinet.

Because of the unique Zenith "selector," unusual selectivity is accomplished without complication of adjustment.

The Zenith 4R may be connected directly to any loud-speaker ***without*** the use of other amplification for full phonograph volume, and reception may be accomplished over distances of more than 2,000 miles..... $85

ZENITH RADIO CORPORATION,
Dept. 1-O 328 South Michigan Avenue, Chicago, Illinois

Gentlemen:
Please send me illustrated literature on Zenith Radio.

Name.....

Address.....

Courtesy Zenith Radio Corporation

This is an old Zenith radio advertisement which ran in several publications in 1924, nearly five decades ago. It was an exciting era of long-distance wireless communication and Arctic exploration. Note the line under the radio: Licensed under Armstrong U. S. Patent. That was radio pioneer Edwin Howard Armstrong, inventor of the regenerative feed-back principle of amplification (Electronics Digest, January/February 1971).

History of the Vacuum Tube

Some of the more important historical types of gas tubes are discussed in this article. It serves as a useful foundation for treatment of other basic electron tubes

Part IV

by Robert G. Middleton

We have noted that the earliest vacuum tubes were "soft"; that is, these tubes contained sufficient residual gas so that their characteristics were dominated by ionic conduction. Actually, there is no perfect vacuum condition in tubes, although "hard" tubes were evacuated to so great an extent that ionic conduction could be disregarded for practical purposes. At about the turn of the century, it was known that certain types of "soft" tubes operated as rectifiers. The groundwork had been laid in 1850 by Geissler, who discovered that colored lights could be produced by means of a high-voltage discharge through a tube containing gas at a low pressure.

Cooper Hewitt Mercury-Arc Rectifier

Soft tubes containing mercury vapor were extensively developed by Peter Cooper Hewitt, including the Cooper Hewitt mercury-vapor lamp (Figs. 1 and 2). Iron electrodes are located at *a* and *b*. Electrode *b* contacts a small pool of mercury. A metallic coating *d* is placed around the mercury pool, to provide capacitor action for easy starting. However, this type of tube requires a high starting voltage, usually provided by an induction coil or step-up transformer. The starting voltage was applied momentarily between *a* and *b*. Although several thousand volts were required to fire the tube, the arc drop fell to approximately 50 volts thereafter.

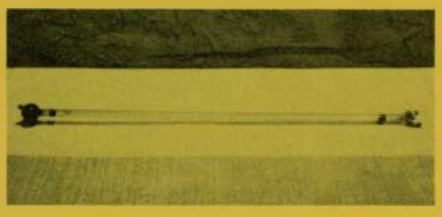


Fig. 1 A Cooper Hewitt mercury-vapor lamp.

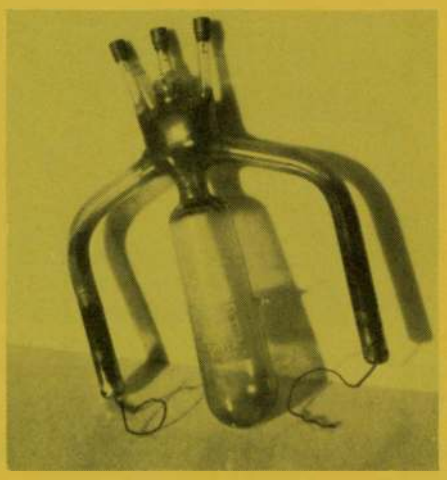


Fig. 3 A Cooper Hewitt mercury-arc rectifier tube.

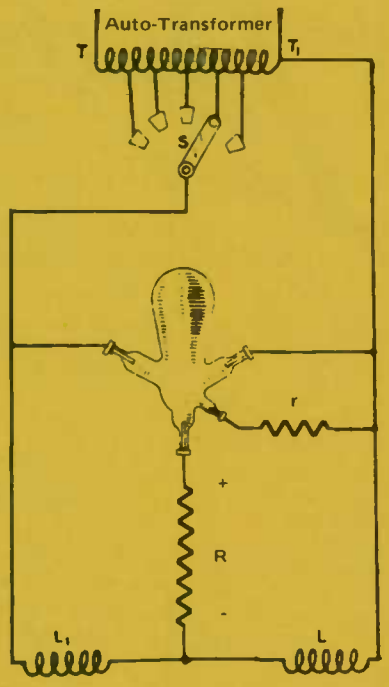


Fig. 4 Plan of the Cooper Hewitt mercury-arc rectifier tube.

Discovery of the fact that the mercury-vapor lamp operated as a rectifier was based on the observation that operation was possible only on dc, with the mercury pool employed as the negative electrode. Later, the mercury-vapor tube was operated on ac by means of a circuit expedient. A large inductor was connected in series with the tube. In turn, the flywheel action of the inductor sustained current flow through the tube during the inoperative half cycle, so that the arc was not extinguished during this period. Because the lamp developed peak output on alternate half cycles, it exhibited an objectionable stroboscopic effect.

Hewitt was intrigued by the rectifier action of the mercury-vapor lamp, and soon developed the mercury-arc rectifier tube (Figs. 3 and 4). This tube was extensively used to change ac to pulsating dc in most applications which demanded substantial current and good efficiency. Operating voltage is applied by the transformer to the iron electrodes. The mercury pool is connected through load *R* to a pair of inductors and thence to the iron electrodes. An auxiliary starting electrode is also connected via resistor *r* to one of the iron electrodes.

To start the mercury-arc rectifier tube, the mounting is momentarily tilted or turned clockwise, so that the mercury pool contacts the starting electrode. In turn, mercury is vaporized and the tube starts operation. The mercury pool serves as the cathode, and electrons flow on alternate half cycles into one or the other of the iron anodes. Inductors *L* and L_1 are used for their flywheel effect. Otherwise, the rectifier tube would become extinguished or deionized when

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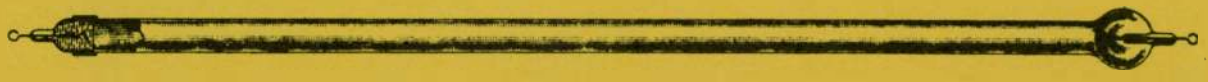

Fig. 2 Construction of the Cooper Hewitt mercury-vapor lamp.

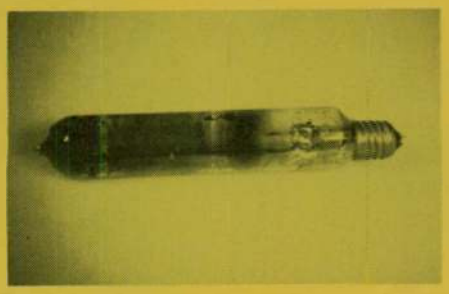

Fig. 5 A filamentary type of mercury-vapor lamp.

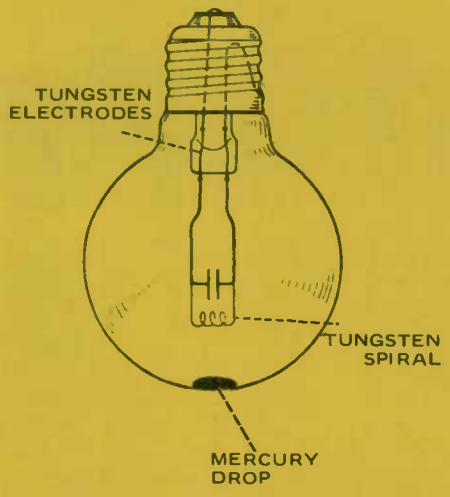

Fig. 6 Plan of a filamentary mercury-vapor lamp.

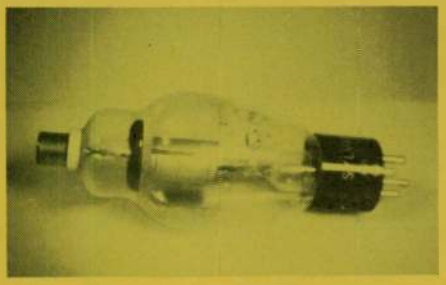

Fig. 7 A hot-cathode mercury-vapor rectifier tube.

HISTORY OF THE VACUUM TUBE

(Continued from preceding page)

the current path changes from one anode to the other. A mercury-vapor tube radiates a bright purple light.

Hot-Cathode Mercury-Vapor Tubes

Although the Cooper Hewitt tube operates with an intensely hot spot on the surface of the mercury pool, it is fundamentally a cold-cathode design in that no filament or heater is provided for electron emission. In contrast, there is the hot-cathode (incandescent filament) mercury-vapor lamp (Figs. 5 and 6). When current flows through the filament, the vapor pressure of the mercury rises, and the mercury vapor is ionized by electron emission from the filament. Thereupon, a mercury-arc discharge takes place between the tungsten electrodes. This arrangement is often used as a source of ultraviolet radiation.

A mercury-arc discharge is easily started (and sustained) by electron emission from a hot cathode, a feature exploited during the 1930's by rectifier tube engineers. One example is the hot-cathode mercury-vapor rectifier tube (Fig. 7). It employs a coated type of filament, which must be operated for at least 15 seconds before anode voltage is applied. Thereupon, the mercury vapor ionizes and radiates a purple glow. The tube drop is only 15 volts when 7,000 volts are applied at 0.25 ampere current demand. Thus, the tube operates at high efficiency.

A cathode in a mercury-vapor tube emits electrons, and also heats the surrounding space to vaporize the mercury. Therefore, specialized cathode constructions were found necessary (Fig. 8). Heat from the inner turns of the spiral filament is absorbed by the outer turns. Thermal radiation from the outer surface is reduced by means of a polished shield surrounding the filament. The plate, or anode, is a metal cup fitting over the top end of the cathode. To avoid tube damage in operation, the cathode must be able to emit more electrons than are demanded at peak anode current flow. Thus, a mercury-vapor tube has no advantage over a high-vacuum tube in this regard; its advantage is its high efficiency, due to the low tube drop.

Argon Gas Rectifier Tubes

Another classical type of hot-cathode gas tube utilizes argon, and was called a Tungar or Rectigon tube. One variety of tube contained a mixture of argon and mercury vapor. Mercury-vapor tubes of all types were termed phanotrons. Typical phanotrons are the Tungar bulbs (Figs. 9 and 10). A spiral tungsten filament was employed, with a graphite anode. The gas pressure was approximately 5 centimeters of mercury. To obtain ample electron emission, the tungsten filament was operated at a much higher temperature than that in a high-vacuum tube. Because of the argon gas, the tungsten was inhibited from excessive evaporation, and the tube was fairly long-lived.

Thyratron Tubes

A thyratron tube is basically a three-electrode gas tube or phanotron. That is, a thyratron contains a control grid in addition to the cathode and anode

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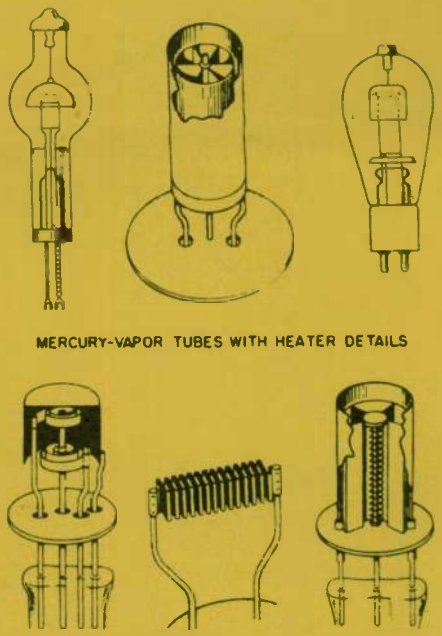

Fig. 8 Hot-cathode construction for mercury-vapor rectifier tubes.

Fig. 9 Representative Tungar bulbs.

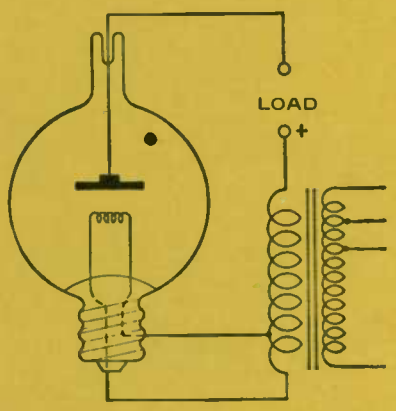

Fig. 10 Plan of a Tungar rectifier bulb.

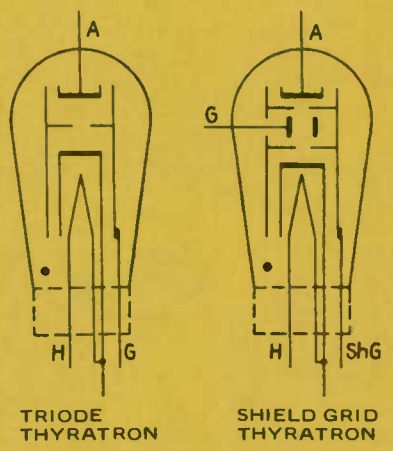

Fig. 12 Internal construction of triode and tetrode thyratrons.

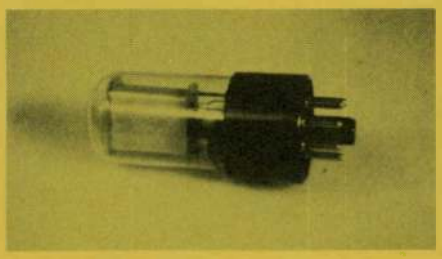

Fig. 11 Appearance of a small thyratron.

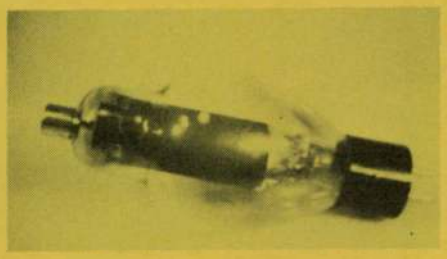

Fig. 13 A larger type of thyratron.

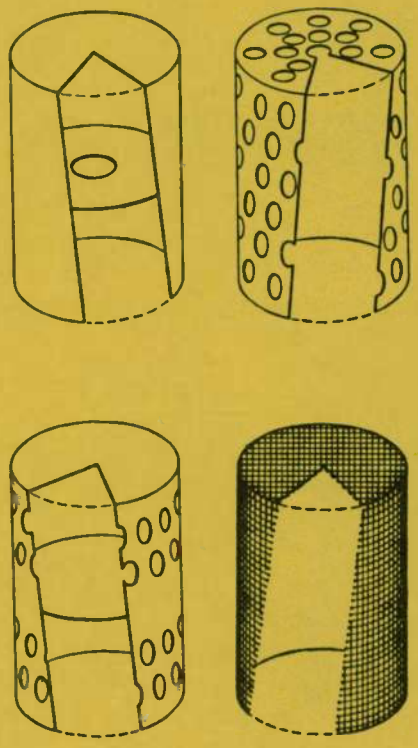

Fig. 14 Conventional thyratron grid constructions.

HISTORY OF THE VACUUM TUBE

(Continued from preceding page)

(Figs. 11 through 13). The control grid in a thyratron does not have an operational function at all times, as in a high-vacuum tube. Instead, a thyratron grid can only inhibit anode current flow (ionization) up to a certain critical grid voltage. Thereupon, the tube "fires" and the grid loses control. Anode current can then be stopped only by bringing the anode voltage to zero. Then, the grid resumes control.

Note in Fig. 12 that the grid in a thyratron is designed differently from a grid in a high-vacuum tube. A thyratron grid shields the cathode both from the anode and from the walls of the glass envelope. Thereby, the effect of stray fields is minimized and operation is stabilized. In typical thyratron grid constructions (Fig. 14), control action takes place through a hole, pattern of holes, or screening. A double-grid or tetrode type of thyratron provides shielding for the control grid, in addition to the cathode and anode. In turn, maximum operating stability is realized. This type of tube was extensively developed during the 1940's.

Neon Gas Tubes

Many types of gas tubes containing neon or mixtures of neon and other gases have been developed. It was noted previously that work in this field was started by Geissler in 1850. There are various ornamental forms of Geissler tubes (Fig. 15). Present-day tubes used in so-called neon signs are a direct outgrowth of this line of development. During the 1930's neon tubes were utilized in television receivers (Fig. 16). These consisted of a cold-cathode type of gas diode, with a cathode 1 ½ inches square, and a wire electrode serving as the anode. The tube contained neon gas at low pressure, and the cathode surface glowed a reddish-orange when approximately 75 volts were applied between the electrodes. A brighter glow was produced by higher operating voltages.

In this era, television pictures were reproduced on a "screen" 1 ½ inches square, but a magnifying glass was often provided to increase the apparent size of the image. The image was developed by means of a scanning disk (Fig. 17). Since a scanning disk was limited in the number of scanning lines which could be

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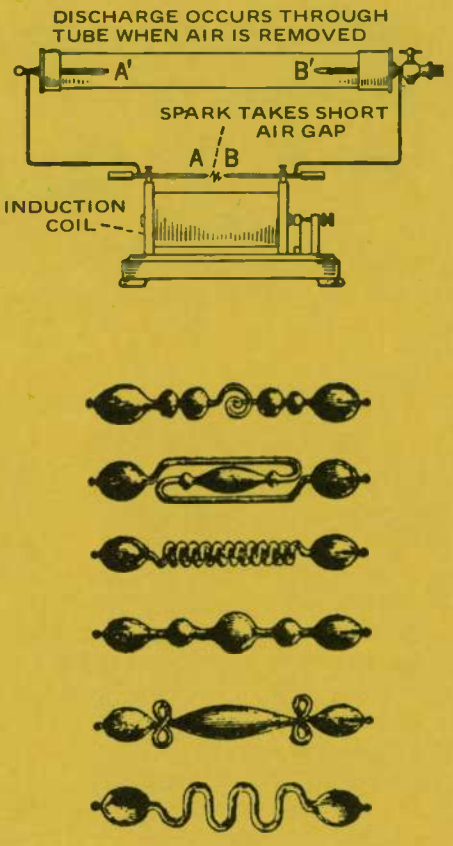

Fig. 15 Geissler tube arrangement, and various ornamental forms.

HISTORY OF THE VACUUM TUBE

(Continued from preceding page)

employed, the reproduced images were necessarily quite crude. To anticipate subsequent discussion, neon tubes were eventually supplanted by cathode-ray tubes in order to provide large and well-detailed images.

There are many other forms of neon bulbs (Figs. 18 and 19). One of their important characteristics is the comparative constancy of voltage drop between electrodes as the current flow changes. The interval from *A* to *B* is called the dark-current region. Breakdown occurs at *B*. Little voltage-drop variation takes place from *C* to *D;* this is the normal operating interval. Arc breakdown ultimately occurs at *E*, accompanied by a very large decrease in voltage drop, increase in current, and often destruction of the tube. The constancy of tube drop provided over its operating interval makes the device useful as a voltage regulator.

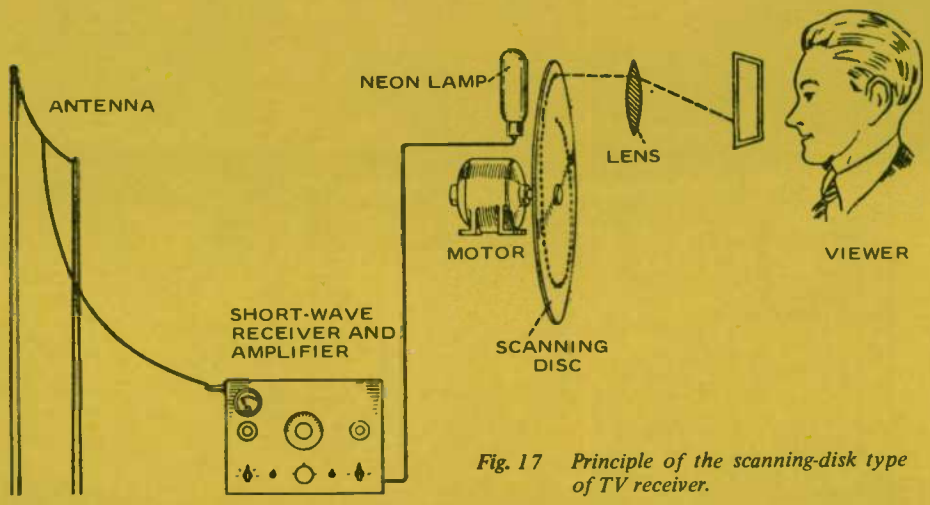

Fig. 17 Principle of the scanning-disk type of TV receiver.

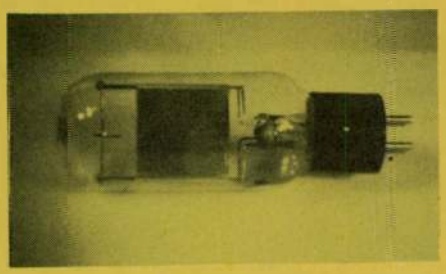

Fig. 16 A neon tube used in a 1930-vintage television receiver.

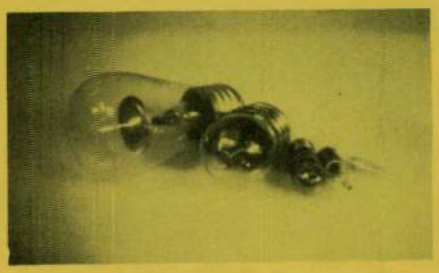

Fig. 18 Some varieties of neon bulbs.

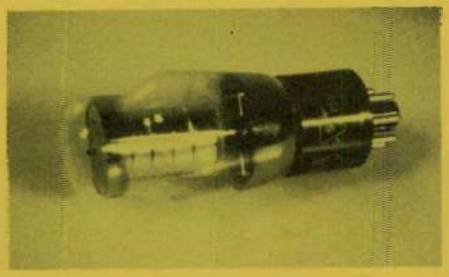

Fig. 20 A voltage-regulator tube.

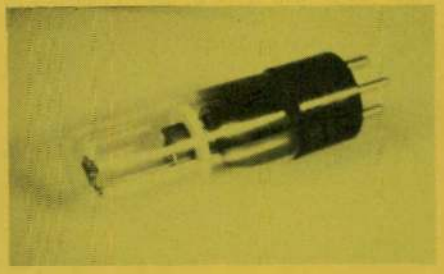

Fig. 22 A strobotron tube.

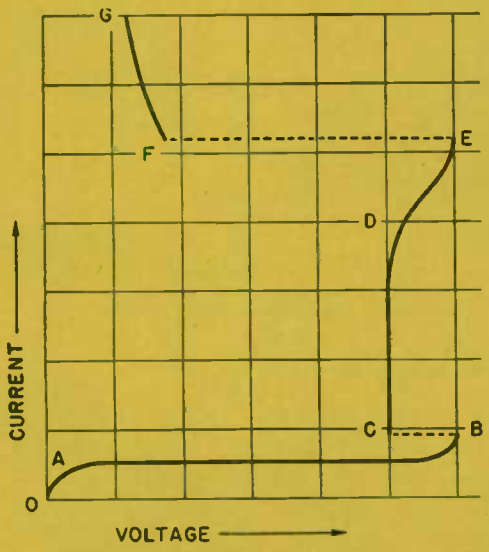

Fig. 19 Voltage-current characteristic of a neon tube.

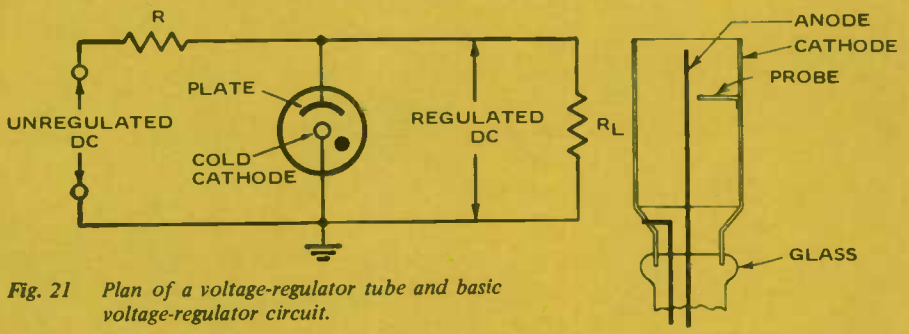

Fig. 21 Plan of a voltage-regulator tube and basic voltage-regulator circuit.

However, whenever substantial current must be accommodated and optimum regulating characteristics are desired, larger gas diodes are utilized (Figs. 20 and 21). These were developed during the 1930's. Various inert gases are employed in voltage-regulator tubes, other than neon gas. Note that in the basic voltage-regulator circuit arrangement a probe is mounted on the cathode and extends into the vicinity of the anode. This structure provides an intensified electrostatic field which facilitates the onset of ionization and thereby increases the dynamic range of the tube.

Strobotron Tube

Although a neon bulb is a stroboscopic light source, it does not have a high-intensity output. Therefore, a specialized glow-tube light source was developed in the 1930's for use in strobe applications, known as the strobotron tube (Figs. 22 and 23). The strobotron tube was designed to maximize the light output from the neon gas content. The cathode is cesium coated, and the two grids are used to start ionization at the firing voltage. As soon as the tube ionizes, the grids lose control, and current flows until the anode is brought to zero potential. Although the strobotron is basically a cold-cathode tube, it is comparable to a hot-cathode thyratron after ionization starts.

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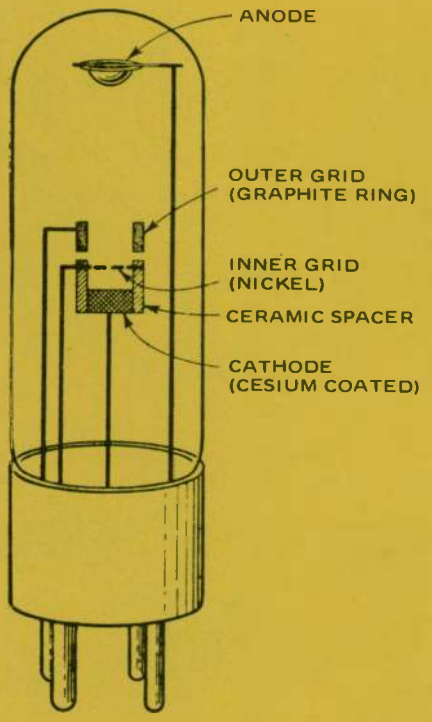

Fig. 23 Structure of the strobotron tube.

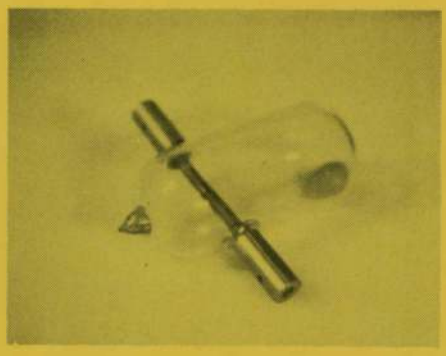

Fig. 24 A small T-R tube.

HISTORY OF THE VACUUM TUBE

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T-R Tubes

During the 1940's various other forms of gas tubes were developed. One important type was called the T-R (transmit-receive) tube (Fig. 24). Used in radar systems, it is basically a spark-gap two-electrode arrangement in water vapor at a pressure of 1 millimeter of mercury. A simple gap at atmospheric pressure has a resistance during conduction of 30 to 50 ohms. The time for deionization is about 10 microseconds. On the other hand, a T-R tube may have a recovery time of 3 microseconds, with a resistance of only a few ohms during conduction. A water-vapor type of T-R tube has a recovery time of 0.5 microsecond.

T-R tubes are usually designed to fit into and to be a part of a resonant cavity (Fig. 25). To facilitate ionization at a low signal voltage, another electrode, called a keep-alive, is often included. This electrode has a potential of about -1,000 volts with respect to the main gap. A low discharge is maintained by the keep-alive and one electrode of the main gap. Thereby, a small signal voltage applied to the main gap easily triggers the T-R tube into conduction.

Conclusion

Some of the more important historical types of gas tubes have been discussed. However, it should not be supposed that other than a preliminary sampling has been presented. The data which have been provided serve as a useful foundation for treatment of other basic electron tubes, such as phototubes, image dissectors, iconoscopes, image orthicons, kinescopes, and specialized tubes utilized in radiation technology.

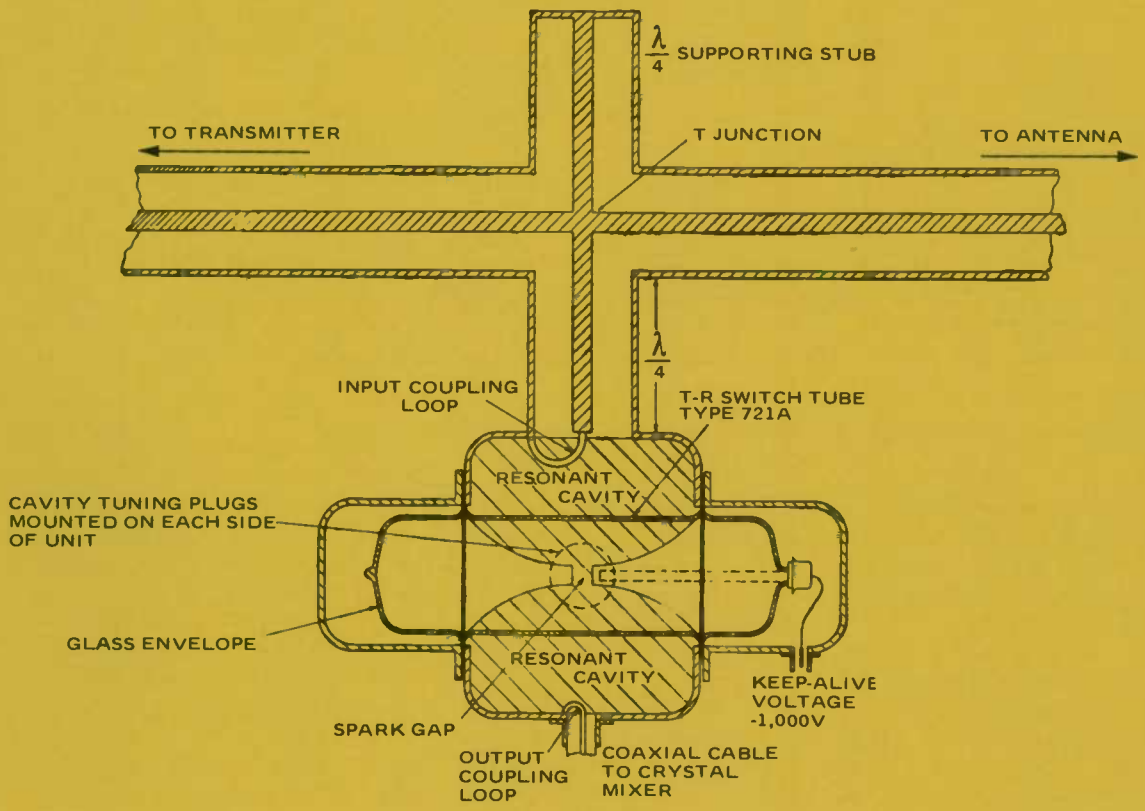

Fig. 25 A T-R tube arrangement.

Prize-Winning Crystal Radio of the 1920s

This simple, easy to construct, crystal radio receiver was a big hit in the early 1920s. It was billed in advertisements as "the simplest radio outfit made – yet as practical as the most expensive"

By Arthur Trauffer

In the early 1920's, Hugo Gernsback, editor and publisher of "Science and Invention" and "Radio News" magazines, offered a first prize of $100 in gold to the reader who could construct the simplest practical "radiophone receiver" that would give good results.

Out of about 800 contestants, the editorial staff of "Science and Invention" awarded the first prize to young James Leo McLaughlin of New York City for a simple crystal radio he built in about a half hour from easily-obtainable materials, at a cost (at that time) of about 40¢ – not including the earphone and antenna, and which worked as well as many crystal radios on the market at that time. Instructions for building McLaughlin's radio were published in "Science and Invention," sometime later in "Literary Digest," and finally appeared in the book "Practical Radio" by Henry Smith Williams (1922). Radiogem Corporation of New York City put McLaughlin's simple radio on the market in kit form, as shown in the advertisement from "Radio News."

Construction Details

As shown in the illustrations, the simple radio consists of a pint-size paper ice cream container about 3½" in diameter; 13 small and 2 large paper fasteners; 3 small paper clips; a coil of No. 26 enameled copper wire; a common pin; and a piece of galena crystal. Pictorial details of construction are shown in Figs. 1, 2, and 3, and are easy to follow.

To make the "switch points" for the coil, take the container and punch nine holes in it about 1" down from the top and about ½" apart, using a small nail or an ice pick. Into each hole push a small paper fastener. Using pen and ink, number each fastener from right to left from 1 to 9. Alongside hole No. 1 push two small paper fasteners with a small paper clip underneath, and mark it GND for the ground connection.

½" down from GND punch a small hole for the starting point of the coil, which is wound with No. 26 enameled copper wire. Scrape the enamel off the end of the wire, push it through the hole, and wrap it around one of the paper fasteners (GND) on the inside of the container. Pull the wire tight and start winding the coil. The total number of turns on the coil is about 80, and a tap is taken off at each of the following turns: 15th, 23rd, 31st, 39th, 47th, 55th, 63rd, 71st and 80th. In other words, the 15th turn is contact No. 1, and the remaining eight taps are made at every 8th turn. Be sure the enamel is scraped off clean before wrapping the wire around the paper fasteners on the inside of the container.

Figures 1, 2 & 3 show how to make the switch lever from a large paper fastener which slides over the contacts. Push the ends of the fastener through the side of the cover, close to the lid. Bend one end down flush with the side and

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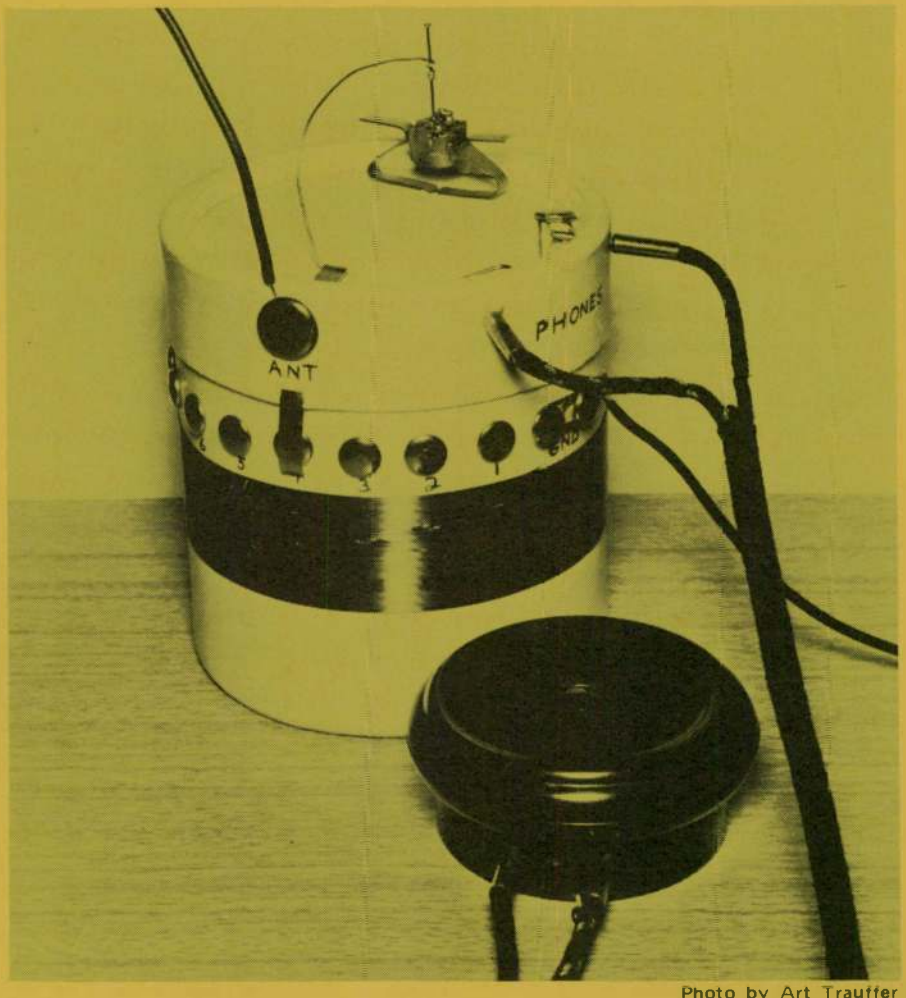

Photo by Art Trauffer

Fig. 1 Again, Arthur Trauffer, of Council Bluffs, Iowa, demonstrates his ingenuity in rounding up parts to build a realistic replica of an early-day crystal radio receiver. These are great projects for a home or school museum. Not only that, they demonstrate principles of electronics as applied in the embryonic stage of radio.

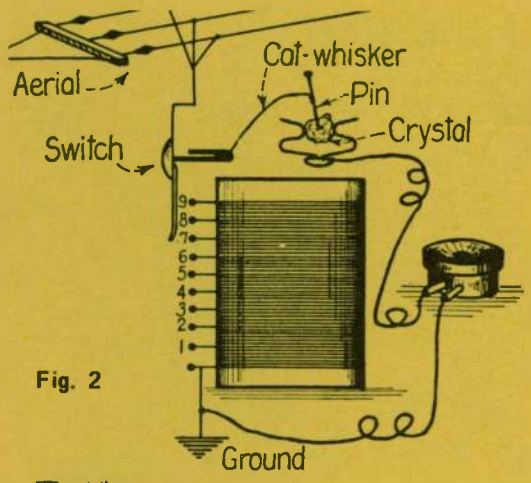

Fig. 2

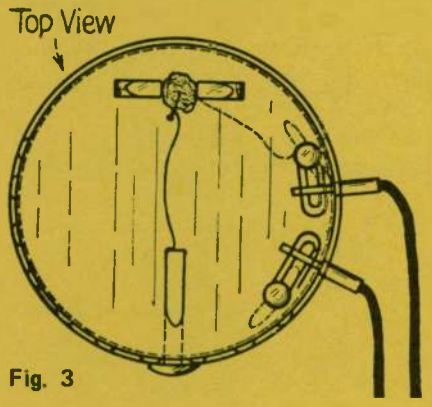

Fig. 3

PRIZE-WINNING CRYSTAL RADIO

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push the other end through the top and bend over. Place the cover on the container and bend the fastener so it rides over the contacts easily when the cover is turned, being sure it touches each of them. Cut off the surplus end.

The other large fastener is pushed through the lid opposite the switch and is bent, as shown in the illustrations, so it holds the crystal. The catwhisker for the crystal is made from a short length of No. 24 wire and a common pin and fastened as shown in the illustrations.

Figure 3 shows the simple hookup.

The earphone should be high-impedance magnetic, and the more sensitive the better. Crystal earphones can also be used, since they are high-impedance.

Use an antenna from 25 to 100 feet long, and a cold water pipe ground.

Figure 1 shows the replica built by the writer.

It goes without saying that this crystal radio was designed and used in the early days of broadcasting when there were fewer stations and they were operating on lower power, so do not be surprised if you hear several stations at the same time when tuning this set. The nearest and most powerful stations will of course be heard the loudest.

This is a copy of an advertisement of the Radiogem Corporation, circa 1922. It uses the magic of early-day radio, the reception of signals through the air, to sell its little receiver, "The wonder item of the radio age."

PARTS LIST

1 paper ice cream container (about 3½" x 3½").
13 paper fasteners (small size).
2 paper fasteners (large size).
3 paper clips (small size).
¼ lb. No. 26 enameled copper wire (Radio Shack).
1 galena or silicon crystal (mounted or unmounted).
1 common pin.
1 (or pair) high-impedance magnetic earphone [crystal earphones can be used] (Radio Shack).

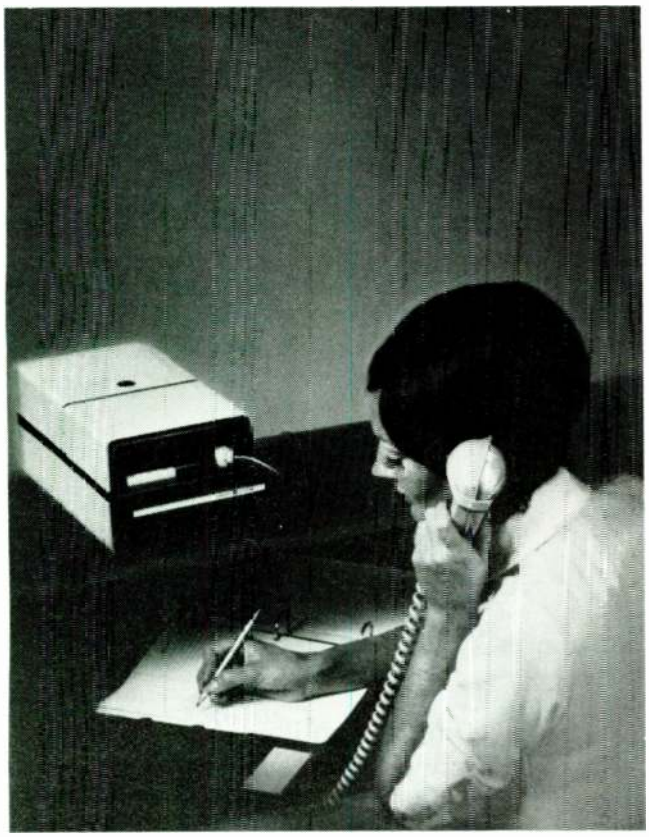
Sources for galena or silicon crystals:

Modern Radio Labs., 754 Cordone, Reno, Nevada 89502 (all kinds of mounted or unmounted crystals. [Present prices not known to this writer).]

Burstein-Applebee, 3199 Mercier Street, Kansas City, Missouri 64111. No. 12A1401 galena crystal 25¢.

The Pacemaker Trans-Telephone System

The pacemaker is a "medical miracle." But the question for the heart patient who uses one has always been: how long will the miracle last? The new trans-telephone system can now give him the answer to this question – and a better life



Photos courtesy General Electric

Technician (left) registers telephone-transmitted pacemaker signal picked up by electronic device held by the patient over the site of his heart pacer (below).

A pacemaker is a battery-powered device for pacing the heartbeat. It was developed in the 1920's and the number of heart patients using this life-saving device has grown enormously since then—about 40,000 at present in the United States alone. The pacemaker is implanted surgically in the heart patient's chest or abdominal area and sends electric impulses to stimulate, according to pre-arranged timing, the number of heartbeats per minute. This "pacing" prevents a dangerous acceleration of the heartbeat, on the one hand, or a possibly-fatal diminution of the heartbeat, on the other. The pacemaker has permitted thousands of severely-handicapped cardiac patients to live normal, productive lives.

One major problem, however, has complicated the lives of pacemaker users: the necessity for frequent surgery—on the average, every 18 to 24 months—to replace the batteries which supply power for the heartpacer. Despite improvements in pacemaker design and reliability, there was until recently no safe and accurate way to predict how much energy-function remained in a pacemaker battery. To guard against the sudden failure of a pacemaker, the batteries were automatically replaced every 1½ to 2 years. It was often discovered during this surgery that a good deal of energy-life still remained in the batteries being replaced and that they could have continued to power the pacemaker for a longer period of time. Now, with the development of the computerized trans-telephone system for checking battery-function, this problem is being solved. Months—even years—of surgery-free living have become a reality for thousands of heart patients.

The trans-telephone system is simple and easy to use: in General Electric's Pulse Detector System a Patient Unit about the size of a small transistor radio is held over the site of the pacemaker generator. The unit picks up the pace-

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maker pulse and converts it into an audible signal, or "beep." A nearby telephone receiver picks up these "beeps" and transmits them to the physician's office, where they are registered on an electronic counting device. The patient himself can hear these "beeps" from the pacemaker pulse and by counting them carefully for a given period, he can determine if his pacemaker is operating properly, provided he knows from his physician what his normal pulse range should be. This system allows the physician to check battery-function either in his office or by telephone, and permits the patient to check it for himself. In ESB's Pacer-Check System the patient places his telephone receiver in the cradle of his unit, grasps one electrode in his left hand and holds the other electrode over the site of the pacemaker battery. The pacemaker pulse is then picked up at the other end of the telephone line and registered on a counting device. An ordinary telephone is used in both these systems and the whole checking procedure takes only a minute or two. When the pulse rate registered on the physician's counting device changes—sometimes only one to two beats a minute—this tells him that the battery is beginning to slope downward into exhaustion, a process which occurs gradually over a period of about two weeks. The physician can then accurately predict when failure will occur and plans for replacement surgery can be made in good time.

The trans-telephone system is already in use in a number of large metropolitan hospitals and clinics and increasing numbers of medical facilities are adopting this system to monitor heart patients over a wide geographical spread. Readable signals for checking have been received from patients as far away as Tel Aviv and Ankara, Turkey, as well as from all parts of the United States. The advantages of the system have revolutionized life for both the pacemaker user and the cardiologist: bedridden patients who are unable to travel to hospitals can be checked in their homes; for heart patients who must leave their home-bases on business or on holiday, a check on their pacemakers is as simple as finding the nearest telephone; overworked physicians do not need to devote examining-office time to a process which can be satisfactorily carried out in minutes by telephone. Perhaps the most important advantage of all is that anxiety—which, in itself, can adversely affect heart function—is reduced: the pacemaker user need no longer fear an unexpected failure of the battery-force which sustains his life. The benefits of the trans-telephone system amply demonstrate, once again, the human impact of electronics in medicine.

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direction of the Astrionics Laboratory of the National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, Alabama.

The Hughes design team expects to provide the five-year life span for the computer by designing highly reliable switches that would bring into action redundant modules when normal operating modules inevitably fail. Even the most reliable computer components cannot be guaranteed to last five years under the rigorous environment of space, according to William Martin, project manager. "NASA is giving increasing consideration to spacecraft multiprocessing systems because the need for in-flight computer capability may increase to levels comparable to demands placed on large commercial installations," Martin explains.

Computer operations which ARMMS may be called upon to perform include guidance, control, navigation, and station keeping, as well as data management, control and evaluation of experiments, environmental control, and displays operation. ARMMS must be reconfigurable to perform its tasks through launch, boost, orbit or coast, and must operate in three basic modes: internally redundant, providing low computational capability but high reliability; parallel processing, so parallel units can handle different tasks, providing high computational capacity with relatively low reliability; operations when only one module of each kind is functioning. Manned launch vehicles and unmanned interplanetary vehicles need high reliability but low computation capability. Large manned earth or lunar orbiting stations require relatively low reliability, but very high computation rates.

The study will be in three phases, beginning with selection and definition of the configuration satisfying the five-year requirement. The necessary redundancy will then be designed into the system. Finally, the Hughes team will develop a more refined design and detailed analysis of the system for NASA.

A computational model of switching mechanisms in long-life modular computers has been developed by Hughes under an earlier NASA contract and this would be augmented for use on ARMMS.

New deep space radiometers

The Santa Barbara Research Center, a subsidiary of Hughes Aircraft, will develop and build infrared radiometers for both the 1975 Viking mission to Mars and the 1977 Mariner missions to Jupiter and Saturn.

The Viking radiometer, called an infrared thermal mapper (IRTM), is intended to measure the surface temperature and thermal balance of Mars. It is similar to radiometers built by SBRC and flown on such earlier planetary missions as the Mariner flights to Mars, with the addition of improvements resulting from the Pioneer/Jupiter experiment. The IRTM is a multichannel radiometer with several detectors in each of five spectral regions. It will measure the reflected solar radiation and surface thermal emission from the area viewed by the orbiter imaging system with a nominal resolution of five kilometers. The Viking program, which will search for evidence of past or present life on Mars, calls for the launching of two spacecraft in 1975, scheduled to reach the planet in 1976. Each spacecraft will consist of an orbiter and a landing craft. One of the tasks of the IRTM, which will be on board the orbiter, will be to assist in selection of a safe landing site most likely to support life.

The contract—awarded by Jet Propulsion Laboratory—for an infrared spectro-radiometer for the 1977 Mariner missions to Jupiter and Saturn calls for evaluation of approaches to the instrument design and study of critical components based on SBRC's experience with similar programs.

MILITARY

TOW systems for helicopter

8 U. S. Army HueyCobra attack helicopters will be equipped with TOW anti-tank missiles and a fire control system developed by Hughes Aircraft under a $16.4 million contract from Textron's Bell Helicopter Company. The TOW systems include a gyrostabilized sight system which automatically isolates the sight from helicopter vibration and motion. In operation, the gunner simply holds his target in the sight crosshair and presses a trigger to launch the missile, which will then automatically follow the gunner's line-of-sight, impacting on the spot on which the crosshair is sighted. The HueyCobras can carry two or four missiles on each side in launcher pods and the new fire control systems will give the attack helicopters the capability to knock out hard-point targets such as fortified gun emplacements, bunkers, and either moving or stationary tanks and armored vehicles.

Photo Courtesy Hughes Aircraft Company

New sting for the cobra – A HueyCobra attack helicopter with new TOW anti-tank missiles in launcher pods on each side.

Test system for supersonic B-1

Both Instrument Systems Corp. and IBM will provide components for a Central Integrated Test System (CITS) for the new supersonic B-1 Air Force bomber. North American Rockwell, prime contractor for the B-1, calls CITS the first truly integrated onboard test process to display to crew mem-

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bers the performance of an aircraft's many systems for evaluation of mission capability. In addition, CITS will detect, isolate and identify failed equipment for maintenance purposes; the highly advanced internal test system is expected to drastically reduce maintenance costs on the new bomber. The CITS will utilize data acquisition equipment, a computer, multiplexing (a single wire carrying many different signals) and a display and control panel to carry out its vital function on the B-1. The unique system will check out 29 B-1 subsystems, such as hydraulic, electrical, and flight control. The importance of such an advanced trouble-shooting system to the men who will fly and maintain the B-1 is underlined by the requirement that the four-engine bomber serve as the Strategic Air Command's main bomber deterrent into the 21st century.

The supersonic B-1 is designed to replace eventually the aging subsonic fleet of B-52 heavy bombers that have been in service with the Strategic Air Command for more than 15 years. The B-1's primary designed-in mission is low-level penetration. Flying at nearly the speed of sound, while hugging the ground, the B-1 will use natural terrain contours as shields from radar detection—the heart of all modern anti-aircraft defenses. In addition to its low-level capability—a first for heavy bombers—the B-1 will be able to fly at twice the speed of sound (approximately 1,400 mph) at high altitudes. First flight of a B-1 is scheduled for spring of 1974 and the bomber will undergo a year of intensive flight testing before Congress makes a decision on full production. If the program is affirmed by the Congress in 1975, the Air Force plans to order 241 B-1's.

AWARDS

First Zworykin recipient named

Cited for his "outstanding achievements in the field of electronic engineering in the service of mankind," Dr. Ivan E. Sutherland, vice-president of research and development for Evans & Sutherland Computer Corporation in Salt Lake City, was recently named first recipient of the Vladimir K. Zworykin Award of the National Academy of Engineering. He received the $5,000 award at the Eighth Annual Meeting of the Academy in Washington.

Born in Hastings, Nebraska, in 1938, Dr. Sutherland was educated at the Carnegie Institute of Technology, the California Institute of Technology, and holds a Ph.D. in electrical engineering from the Massachusetts Institute of Technology. His doctoral thesis, "Sketchpad," resulted in the first modern computer graphics system, and his research efforts for the Advanced Research Projects Agency and as an associate professor of electrical engineering at Harvard have contributed to information processing techniques and to the advancement of display technology. Dr. Sutherland is currently an associate professor of electrical engineering at the University of Utah, where he continues research in computer graphics.

The Zworykin Award, supported by the RCA Corporation, honors Vladimir K. Zworykin, one of the pioneers of electronics. Dr. Zworykin's invention of the iconoscope led to the development of television.

The National Academy of Engineering was founded in 1964 to provide a major forum for significant problems in engineering and technology. The Academy's 352 members were elected in recognition of important contributions to engineering theory and practice or unusual accomplishments in the pioneering of new and developing fields of technology.

Naval scientists honored

Three scientists at the Naval Research Laboratory in Washington, D. C., were recently selected for 1972 Research Society of America awards. Dr. Bruce D. McCombe of the Laboratory's Solid State Division was selected for the Society's pure science award, and Drs. Vincent J. Linnenbom and John W. Swinnerton of the Laboratory's Ocean Sciences Division were selected for applied science awards.

Dr. McCombe's award cites his distinguished research in studies of semiconductors using magneto-optical techniques. He utilized far IR spectroscopic techniques to investigate the electronic energy spectra of semiconductors in a

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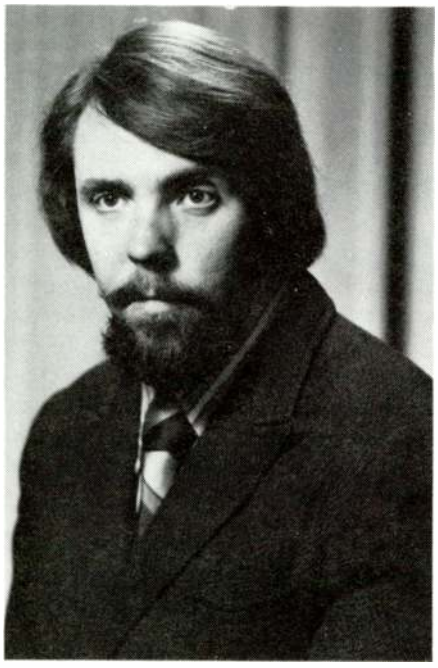

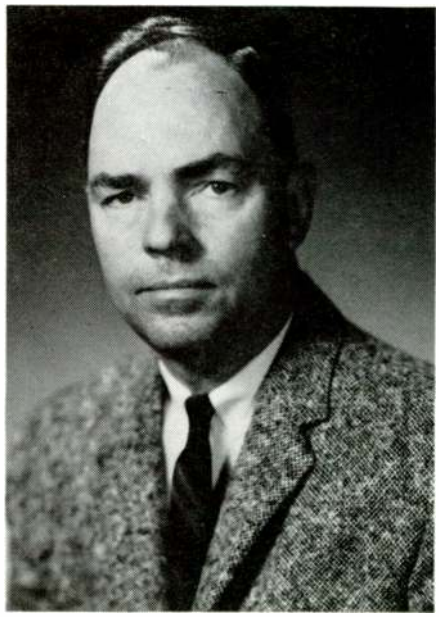

Above–Dr. Bruce D. McCombe
Right–Dr. Vincent J. Linnenbom

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magnetic field. These studies included the first observation of combined resonance in a semiconductor (cyclotron resonance plus spin-flip), and the first unambiguous observation of electric-dipole-excited electron spin resonance in the far infrared. The measurements provided detailed information about the spin states of electrons in narrow gap semiconductors. Dr. McCombe has also conducted fundamental studies of electron-optical phonon (polaron) interaction, and he recently established the presence of electron-plasmon (plasmaron) interaction in semiconductors.

The citations accompanying the applied science awards of Drs. Linnenbom and Swinnerton emphasize the outstanding contributions by the two Naval Research Laboratory scientists in the field of chemical oceanography, through their pioneering research into novel methods for shipboard determination of extremely small quantities of dissolved gases in seawater. Utilization of these methods has led to the discovery that the oceans are a major source of carbon monoxide, comparable in magnitude to man-made sources. The Society's award citation states that this "innovative research in the environmental sciences" makes it possible to put man's impact on the global environment into its proper perspective.

Dr. John W. Swinnerton

Illinois professor chosen

Prof. Josea B. Cruz, Jr., a professor in the department of electrical engineering and a research professor in the Coordinated Science Laboratory of the University of Illinois at Urbana-Champaign, was recently selected to receive the 1972 Curtis W. McGraw Research Award of the American Society for Engineering Education. The award for creative leadership in engineering research combined with excellence as an educator was established in 1957 to recognize outstanding early achievements by young engineering college research workers and to encourage continuance of productivity. Prof. Cruz receives the award for his contributions to a basic understanding of processes underlying automation and complex engineering systems involving feedback, and for his active participation in educational innovation on both graduate and undergraduate levels. The $1,000. award was presented during the society's June meeting at Texas Tech University, Lubbock.

NEW RESEARCH

Moving vehicle gravity sensor

A $½ million contract for the design and development of a gravity gradient sensor to measure changes in the earth's gravity field from a moving vehicle has been awarded to Hughes Aircraft Company by the U. S. Air Force Cambridge Research Labs. The sensor will be based upon principles first demonstrated in the Hughes lab more than five years ago. The gradiometer utilizes a rotating, mechanically resonant structure to measure the static gradients of the gravity force field with more accuracy, rapidity and efficiency than existing instruments provide. The principal aim for the prototype instrument—to be developed over a two-year span—will be the capacity to measure the weak gravity field gradients while withstanding the motions and accelerations of a ship or airplane. The new sensor can also be potentially applied directly with inertial guidance systems to correct errors presently resulting from distortions in the earth's gravitational field.

COMPUTER TECHNOLOGY

New library retrieval system

A computer-operated retrieval system which can quickly provide information on 15,000 articles in physics journals and automatically print summaries of this research recently began operation at the University of Illinois, Urbana-Champaign. James Divilbiss, who supervised development of the system, believes it is the first of its kind anywhere.

Each month the system will receive indexed information on up to 2,500 articles from 70 journals recorded on magnetic tape by the American Institute of Physics. Users type commands on a keyboard terminal connected to the computer by telephone. Within one-fourth of a second, the computer searches its memory discs and sends retrieved information to the terminal for printout. Review of published research for a new investigation—which would normally require a laborious search through printed indexes — can be completed in seconds with the new retrieval system: it can print abstracts of up to 10 articles at a time; list bibliographical data for articles on any one index topic or combination of two topics; and retrieve and list similar articles, or all articles written by one physicist. With enlarged memory capacity, Divilbiss says, the system could store abstracts, titles, topics and authors of nearly all articles on physics research published since January, 1971.

The system may eventually become part of the university's PLATO computer-assisted instructional system. Physics information would then become available to users at 4,000 terminals planned for a 150-mile radius of Urbana.

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SWISS SYMPOSIUM

National energy policy urged

Speaking recently to power-industry colleagues from around the world at an international symposium in Lucerne, Switzerland, William R. Gould, senior vice-president of the Southern California Edison Co., made a strong plea for a comprehensive national energy policy which would allow the utility industry full responsiveness to changing environmental and social goals. The lack of such a policy seriously undermines the interests of both industry and public, Gould alleges. It results in piecemeal energy planning and chaotic licensing structures which frequently lead to delay or cancellation of environmentally-preferred generation plant — most often of the nuclear form. No guidelines exist for confronting environmental demands; thus, "decisions involving large sums of money and major commitments of public resources must be made without any determination that they are consistent with the public interest," says Gould.

Public values are changing; the electric-utility industry must strive for a greater degree of accommodation to these changes, Gould maintains. A national policy should be based on awareness of the dual need to maintain economic health and to meet emerging environmental challenges. Until such a policy is formulated, Gould advises utilities to adopt a series of interim measures which include responsiveness to those who question or oppose utility projects; inclusion of informed environmental groups in utility decision-making; expansion of public awareness of the environmental and social costs of energy and what the intelligent use of energy means; the design of new generating facilities to provide for the addition of pollution-abatement systems as they become technically feasible; and the adoption of a systems-analysis approach to decision-making which takes into account the full spectrum of social concerns. A "major historical objective" of the power industry — the provision of "an abundant, low-cost energy supply," must be modified to provision of "an adequate, low-cost energy supply," Gould stresses. And both utilities and the public must be encouraged to understand the necessity for this changed goal—and its implications. "The resources of this planet are of finite quantity," Gould says, "and therefore growth as we have known it in recent decades cannot continue indefinitely."

More than 100 industry and government representatives from 17 countries gathered in Lucerne for the three-day symposium, which was sponsored by the Swiss Association for Atomic Energy, in cooperation with the New York-based Atomic Industrial Forum.

TYKOCINER LECTURE

"Science in the new society"

Physics—through atomic power—has made its great contribution to a long-lived, stable industrial civilization; now the "greatest task falls to biologists . . . our main hope is in biological technology," according to Dennis Gabor, Nobel Prize-winning physicist, in the first Tykociner lecture—"Science in the New Society"—at the University of Illinois Urbana-Champaign campus. "I would redirect all talents from high-energy physics, computers and such luxuries, into chemistry, biochemistry and the biological sciences," Gabor said. "These are necessary for survival." And survival of the human race is the challenge which faces the next generation of inventors.

Gabor, who received the 1971 Nobel Prize in physics for his invention of holography (sometimes called "lensless photography"), spoke of the need for scientific and industrial adjustment to changing social goals. "Chemists," he said, "must supply us biodegradable plastics and organically-based substitute materials for irresponsibly-used rare metals." As for industrialists, Gabor said, "there are great men among them and their influence is needed on the politicians to redirect research towards survival and to lead the great transformation which will be required in the economic system of the free countries." Two parallel themes ran throughout Gabor's Tykociner lecture: the need to conserve our resources and the related need to readjust our research to the paramount goal of man's survival.

Tykociner was a pioneer in wireless and electronics and the father of modern sound movies. The first Tykociner lecture commemorated the 50th anniversary of the scientist's 1922 demonstration of sound-on-film motion pictures. Tykociner, like Gabor, was a man of wide interests and devoted the last quarter-century of his life to zetetics, a new science concerned with research and the organization of all areas of knowledge. Gabor is himself both physicist and engineer and his breadth of interest can be seen in the books he has written, which include "Inventing the Future," "The Mature Society," and "Innovations: Scientific, Technological and Social."

NEW PRODUCTS

Westinghouse sonar detector

A detection principle best known for locating submarines and underwater mines is surfacing—at Westinghouse Electric Corp. — as a solid-state sonar unit suited for applications ranging from counting bottles to detecting people. The Universal Object Detector (UOD) uses the echo-ranging principle of shipboard sonar: the range of an object is determined by measuring the time a signal takes to travel round-trip between object and sensor. The UOD—which measures 4 by 8 by 12 inches and weighs 11 pounds—will silently detect an object up to 6½ feet away by bouncing off of it a narrow beam of pulsating ultrasonic sound waves. The presence of an object triggers a built-in static switch that can be used to activate alarms or tie in with other supervisory or sequencing circuitry. A unique feature of

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the UOD is that it can selectively ignore objects entering its zone of control and can be adjusted to respond only to objects appearing at a particular, preset distance from the unit. This allows the device to be used, for instance, to actuate brakes on a steel mill crane when it approaches within a certain distance of another crane. Other possible applications of the UOD include counting parts, controlling fluid levels, handling and positioning materials, detecting intruders or inspecting finished products for missing parts. The device has no moving parts and is virtually maintenance free; it is easy to install, since ultrasonic waves are transmitted and reflected sound received by the same self-contained unit. The UOD can detect almost any material through dust, smoke, steam or snow.

EDUCATION

UTA offers special course

The University of Texas at Arlington electrical engineering department is offering a special one-week short course August 21-25 on "Thermoelectric Devices and Their Applications." Enrollment is limited to 30 and advance registration is required (interested persons should write the course director, Dr. K. R. Rao, at UTA, Arlington, Texas 76010). Sole prerequisite is a B.S. degree in engineering or science, or the equivalent. Registration fee of $200. includes instruction, printed notes or text, and graduation luncheon. The course is designed to familiarize the engineering, scientific, medical and academic community with current design, fabrication and operation of thermoelectric devices and their application to aerospace, power systems, medicine, biology, electronics and related fields.

REPORTS

Radioactive waste management

A promising prospect for safe long-term storage of radioactive wastes from the Atomic Energy Commission's Savannah River Plant in South Carolina is placement in bedrock deep beneath the plant, a National Research Council committee has concluded. In a report prepared for the AEC, the NRC committee states that this disposal method offers a "reasonable prospect" of protecting the biosphere from radioactive wastes for the 1,000 years recommended by the committee.

Before final placement in underground vaults, the wastes would be held in interim storage in underground tanks for at least ten years to allow for decay of short-lived radionuclides — strontium-90, cesium-137, and plutonium-239 are the three principal of these, with strontium-90 the most hazardous to humans and animals because it is readily absorbed from food and water and retained in bones for long periods. The aged wastes, mostly in the form of moist salt cakes, would then be suspended or redissolved in water and pumped into the rock vaults, where the slurry would separate into a sludge and a liquid. The interim storage tanks could then be cleaned to a low level of residual radioactivity.

The NRC panel stresses that before a final decision on storing the wastes in bedrock vaults is made, exploratory shafts and tunnels must be constructed to permit extensive study of the method's safety. The report further recommends that while this research is in progress, study should continue on alternative methods of handling the wastes.

Currently, the wastes from the Savannah River Plant are stored underground in 28 double-walled, carbon-steel tanks. For this storage method to be safe indefinitely, the tanks would have to be replaced every few decades and the system would require continuous technical surveillance.

Solar energy for growing nations

Solar energy is of special interest to developing areas of the world because most of these areas are in or near the tropics where sunshine is plentiful and conventional fuels are scarce. People in these growing nations already rely on the heat of the sun for such simple tasks as preserving food by drying and producing salt from seawater. According to a new report by a panel of the National Academy of Sciences, presently available technology might allow developing nations to harness the sun to heat water for homes and hospitals and to distill water for drinking. With significant research and development efforts, processes may be perfected within a decade for using solar energy to heat and cool buildings, refrigerate food, and produce electricity for specialized low-power needs. Solar energy "has the capability to meet energy needs substantially beyond the applications now being made," the report states; since energy needs are expected to grow by 10 to 15 percent a year in some developing nations — and since conventional energy resources are already strained in these nations, as in industrialized ones — development of this solar potential is important. The report recommends establishing regional centers in developing nations to evaluate supplies and uses of all types of energy and to undertake research into applications particularly suitable to local conditions — ensuring a rational use of solar technology . . . "resting on a clear picture of the 'energy niche' in which solar energy will best fit," and preventing excessive hope in promising but unproven applications of the sun's energy.

Currently, the only available manufactured solar energy devices are solar water heaters, which are widely used in such highly developed areas as Southern Florida and Australia. Solar distillation is producing drinking water on a small scale in isolated towns in Australia and in some Mediterranean and Caribbean communities. Some of this present technology could be adapted to the materials and manufacturing capabilities of the less-developed nations, but further research is required to meet realistically the specific future needs of these nations.

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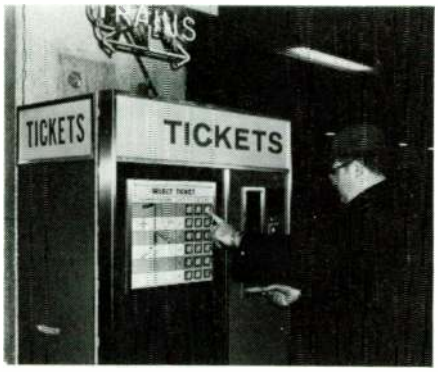
AUTOMATION

Above—new electronic turnstiles that will automatically check passenger tickets during boarding and leaving a train will soon be in operation at one of the nation's largest commuter railroads. Below—a passenger inserts money into an automatic ticket vending machine to receive an electronic coded ticket which will allow him to board the train.



Photos Courtesy Cubic Corporation

New rail passenger system

New automatic ticket vending machines and electronic passenger turnstiles will be provided a major U. S. commuter railroad by Cubic Corp., a San Diego electronics firm, through its subsidiary company, Western Data Products. The $3.4 million contract award is the culmination of more than two years of work by Western Data on the development of an automated passenger system.

The system works like this: a passenger purchases an electronically coded ticket by inserting money into an automatic ticket vending machine. This ticket is then automatically checked by an electronic turnstile when the passenger boards and leaves a train. Time saved both passengers and rail officials is considerable. The automatic ticket vending machines have been in public use since May, 1971; the electronic turnstiles will soon be in operation on one of the nation's largest commuter railroads.

Cubic Corp.'s executive vice-president, Dr. C. J. Breitwieser, feels that this area of automation has a very wide potential application: "We feel we can automate ticket vending and passenger processing equipment in other major commuter railroads, as well as airlines, bus terminals, and even sport stadiums."

TELEVISION

New Holiday Inn cinema system

The Little Rock, Arkansas, Holiday Inn-Downtown recently inaugurated a closed-circuit television entertainment system to be known as Holiday Inn Cinema. The system—which includes both special equipment and movie programs provided by motion picture producers — was developed and installed by Athena Cablevision Corp., a unit of Gulf & Western Industries, Inc. It is the first of several cinema systems to be in operation by early summer in various Holiday Inns across the country.

Holiday Inn guests will be offered current (among the first films on the program: "True Grit" and "The Odd Couple"), complete, uncut and commercially-uninterrupted motion pictures via the TV sets in their own rooms. They are first given a free preview of the movie; if they wish to view it, they then press a button on a control box on their TV sets. A charge — typically $3. — is then added to the guest's room bill. Posters in the lobby and throughout the inn advertise the nightly movies.

Eugart Yerian, an assistant vice-president for Memphis-based Holiday Inns, Inc., and director of the program, describes the system this way: "No special wiring is required in the guest rooms and normal TV programming is not affected because films are contained on video tapes which are inserted into special equipment installed by Athena and played over the inn's master antenna system." Yerian considers the new closed-circuit system a "great boost to traveling families, to businessmen who might prefer to stay in their rooms, and to the increasing numbers of women travelers who often don't want to leave their rooms after dark."

ACADEMY ELECTIONS

New engineering councilors

Four new members were recently elected to three-year terms on the Council of the National Academy of Engineering. The announcement was made by Clarence H. Linder, president of the Academy. The four new councilors are William C. Ackermann, Illinois State Water Survey, Urbana; Paul F. Chenea, General Motors Corp., Warren, Michigan; W. Kenneth Davis, Bechtel Corp., San Francisco; and W. Deming Lewis, Lehigh University. They are among 16 persons serving on the Council, which is the governing body of the Academy.

ELECTRONICS IN MEDICINE

Cinescintigraphy Digital System

A new digital Cinescintigraphy system that can be used with all current commercially available nuclear cameras and scanners for the detection of tumors and anomolies has been developed by Intertechnique of Paris. Designed for acquisition and processing of scintographic data obtained from an imaging device such as a scintiblation camera or rectilinear scanner, the system will supplement Raytheon's line of nuclear medical products. It is available with a mini-computer to correct the inputs, enhance the presentation and broaden the application of the system.

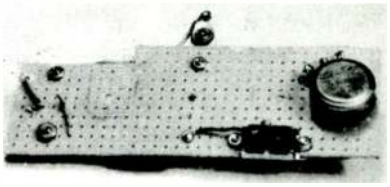
Raw data from the camera or scanner is first digitized and then recorded into the system's core memory, or, optionally, onto magnetic tape for qualitative and quantitative analysis. In either case, the data can be displayed during acquisition. Various operations such as data acquisition and analysis, playback and image subtraction — can be performed on the data for static and dynamic studies.

Electronic Flasher

This practical project features a flasher free of moving parts, springs, and sparking contacts. It has a number of useful applications including emergency warning

Special Science Project

Complete freedom from moving parts, springs, and sparking contacts is possible with this flasher, which is able to switch large currents in a purely electronic fashion. The heart of the circuit is a multivibrator consisting of two transistors – one a small-signal type, the other a large power unit capable of handling relatively high current levels. In operation, a No. 47 lamp is blinked at a nominal rate of one flash every 1.5 seconds. The frequency, as you'll see, can be varied by a small alteration in circuit values.



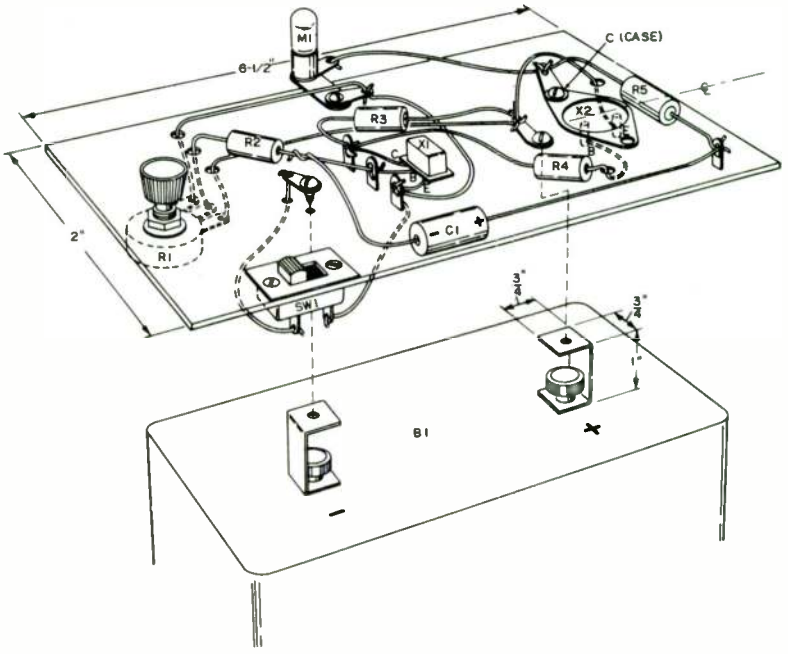


Fig. 1 Pictorial of electronic flasher.

CIRCUIT OPERATION

The basic theory of operation closely resembles that of the code-practice oscillator already described in an earlier chapter. However, there are several superficial differences and the introduction of new transistor types. Notice that X1, unlike the PNP transistor in the earlier project, is an NPN unit (see schematic in Fig. 2). This accounts for its connection into the power supply – emitter to negative, collector to positive through the load resistor. Thus, correct operating biases are provided and the application of a positive voltage on the base of X1 will cause it to conduct and amplify. Comparing the X1 arrangement with that of X2, a PNP transistor, reveals the significant reversal in power connections.

In brief, the multivibrator commences to oscillate when power is turned on. A positive-going pulse at the base of X1 is amplified in the collector and undergoes the phase-reversal characteristic of a common-emitter amplifier. The pulse, now negative-going, is applied to the base of X2 and current is drawn through the lamp inserted in the collector lead. To complete the feedback path needed to sustain oscillation, capacitor C1 samples a portion of X2 collector current and returns this to the input, or base, of X1. The capacitor charges and discharges during circuit operation and the bulb is alternately flashed.

Transistor X2 is a good example of a power transistor which enjoys widespread application by experimenters. Unlike small-signal units used in preceding projects, it is capable of handling several watts of power. This is a requriement imposed by the flashing lamp. Approximately 150 milliamperes must be conducted by the transistor to make the bulb reach full brilliance. The 2N307 is actually rated for higher currents but works well in the circuit, is reasonably priced, and needs no elaborate "heat" sink to prevent a damaging rise in temperature.

CONSTRUCTION

A piece of perforated board, cut to the dimensions given in the pictorial drawing of Fig. 1, serves as the

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ELECTRONIC FLASHER

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chassis. The mounting base will depend on the final use of the flasher. If the unit is to be put into regular service, it will require a rather heavy current supply. This explains the use of a large, lantern-type battery which appears in the original model and the following Parts List. If, however, the flasher is merely built for demonstration purposes, four size-D flashlight batteries may be wired in series to provide a total of 6 volts. This arrangement operates the flasher for a reasonable amount of time, but is not recommended if the unit is intended for possible emergency applications.

The mounting of the circuit board atop the lantern battery is accomplished by two U-shaped metal brackets. As shown in the pictorial, these are drilled, then held in place by the battery's screw terminals and caps. Nuts and bolts are used to fasten the circuit board to the top ends of the two brackets. Be sure to place solder lugs under the screwheads before the chassis is finally mounted in place.

Other major components are fastened directly to the board. A notch is cut for the switch, and large holes are drilled for potentiometer R1 and transistor X2. Note that one solder lug is fastened under one mounting screw of X2. This is the collector terminal. If the transistor is coated with paint, scrape some off so the screwhead makes adequate electrical contact with bare metal on the transistor case. Transistor X1 is conveniently mounted by three small circuit clips pressed into appropriate holes in the coard.

TESTING

Start the checkout with a VOM connected across the terminals of SW1, the on-off switch. With SW1 in an off position, connect the leads of the VOM to two switch lugs – negative probe to the switch terminal which ends at the negative battery terminal. Set the meter to read approximately 200 milliamperes DC. Flashing action begins by locating the correct setting of potentiometer R1. Start with the knob at its most counter-clockwise position. If the circuit is functioning properly, this setting will cause the bulb to remain lit and the meter to indicate about 150 milliamperes. Now start turning the knob slowly to the right until you discover the point which just makes the bulb go dark. The flashing action should now proceed at the rate of approximately once every 1.5 seconds, causing a large needle swing on the meter. The meter leads may now be removed and the switch snapped on.

Next, set up the meter to its 10-volt DC range and connect the positive probe to the solder lug which goes to the positive battery terminal. The negative probe is touched to the base of transistor X1. Note the pattern of the needle swing as the bulb flashes. When the light is on, base voltage reads approximately -5 VDC. During the dark periods, the potential rises to around -8 VDC. This agrees with the theory of operation; a negative-going pulse, indicated by the voltage rise, is converted to a positive-going pulse in transit through X1. Applied to X2, little collector current results and M1 goes dark.

The source of the -5 VDC, before the pulse appears at X1 base, originates at the potentiometer. Note how it is connected across the power supply. As the slider is moved, the desired amount of operating bias is impressed on the base.

Transfer the VOM negative probe to the collector of X1. When the bulb is on, collector voltage is highest. This displays phase reversal occuring through the transistor. In the previous measurement the bulb was on when base voltage was lowest (-5 VDC).

Now shift the negative meter probe to the collector of X2, the power transistor. Note that collector voltage drops from about -6 VDC to nearly zero when the bulb lights. Again, the phase reversal is evident. When X2 base is driven in a negative direction, the collector voltage shifts in a positive direction – actually toward the zero point in this instance.

A final measurement shows the feedback pulse through capacitor C1. If the probes are placed across the capacitor, the charge and discharge voltage can be read on the meter. (Polarity of the meter probes and the capacitor must agree.)

USING THE FLASHER

If the flasher is to be used outdoors, a suitable weather-proof housing should be constructed. A transparent enclosure is recommended to allow maximum light from the bulb to reach the outside. Although the lamp appears to yield a feeble light during daylight hours, actual tests indicate that the flash is visible for approximately one-half mile.

It is possible to alter the rate of flash, if desired. Slowing it down is best accomplished by adding more capacity across C1. Doubling the 30-mfd value will slow the flashing rate to approximately half the former speed.

Faster rates can be secured by reducing C1 capacity. However, too little capacity at this point in the circuit may cause the cycling action to stop completely. Another approach is a change in the value of R5, the 2.2K resistor which controls the rate of C1 charge. If a smaller resistor is used, flash rate increases. In any case, R5 should have a minimum resistance of 1,000 ohms to prevent the feedback pulse from reaching excessively high intensities.

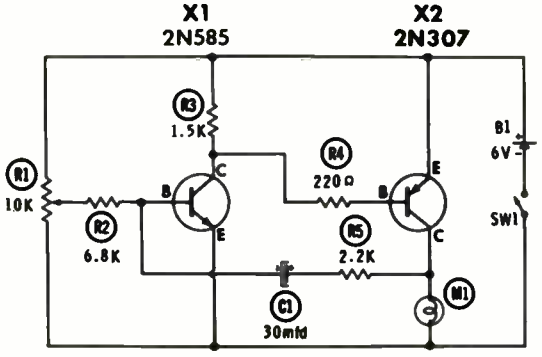
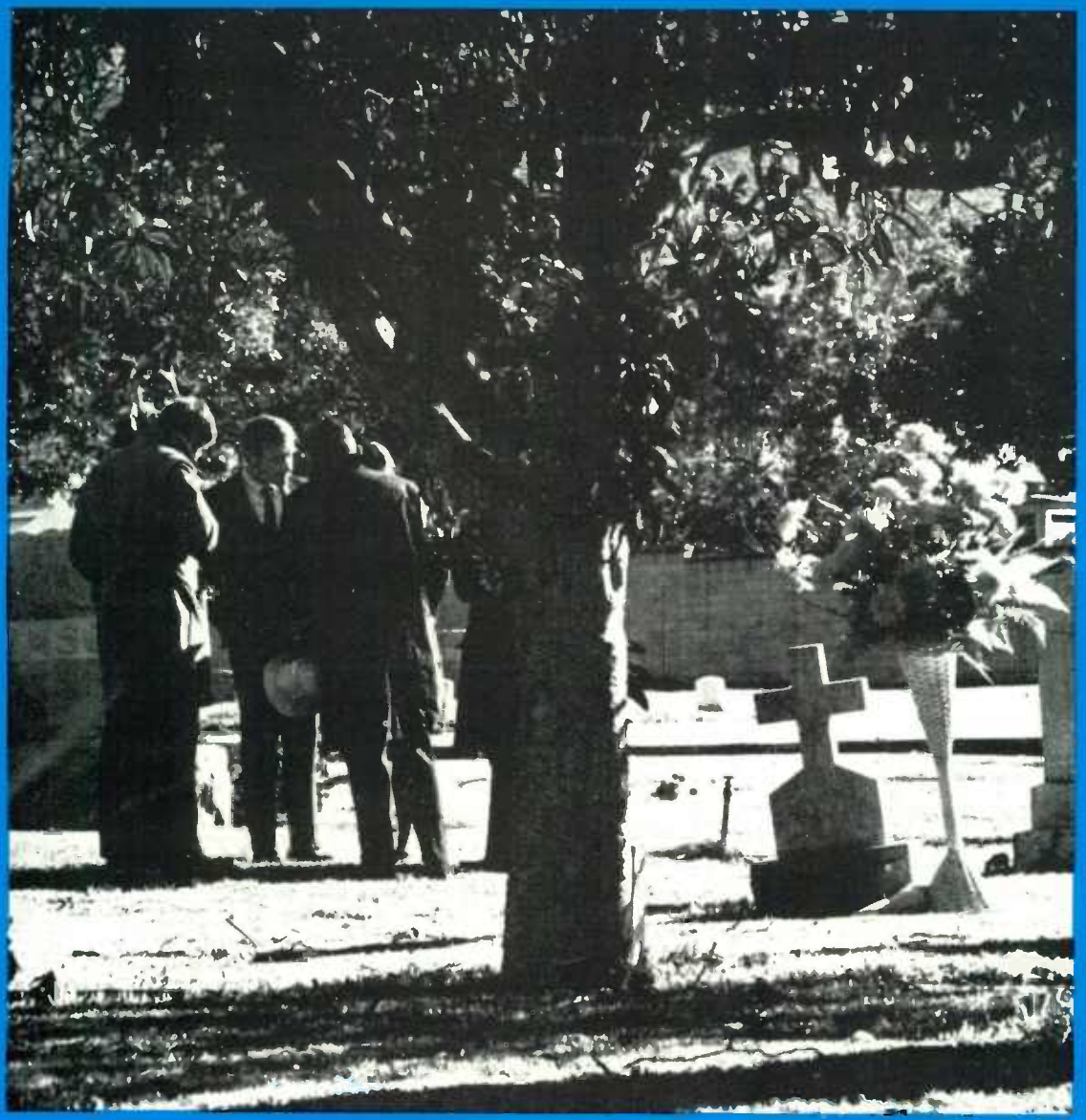


Fig. 2 Electronic-flasher circuit.

PARTS LIST

R1—10K potentiometer (271-1443 $ .99)
R2—6.8K ½-watt resistor (962 B 1800 $ .12)
R3—1.5K ½-watt resistor (962 B 1800 $ .12)
R4—220-ohm ½-watt resistor (962 B 1800 $ .12)
R5—2.2K ½-watt resistor (962 B 1800 $ .12)
X1—2N585 transistor ($1.39)
X2—2N307 transistor ($1.35)
C1—30-mfd 15-volt electrolytic capacitor (755-3085 $ .71)
M1—No. 47 lamp (272 B 1110 $ .39 for 2)
SW1—SPST slide switch (275-401 $ .39 for 2)
B1—6-volt lantern-type battery (737-0559 $3.45)
Misc.—Lamp holder (844 B 3100 $ .50); circuit clips (270-325 $ .69/pkg. of 5); metal brackets, 4 solder lugs (64 B 3029 $ .69/pkg. of 56)

Prices subject to change.



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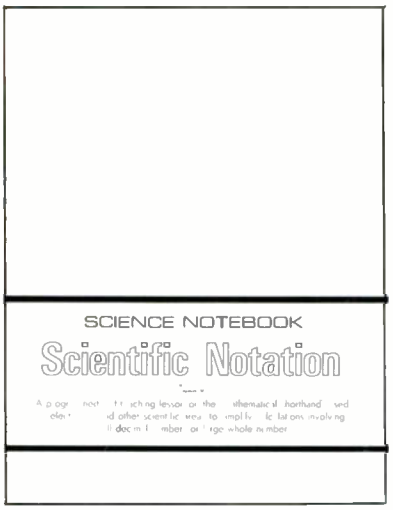

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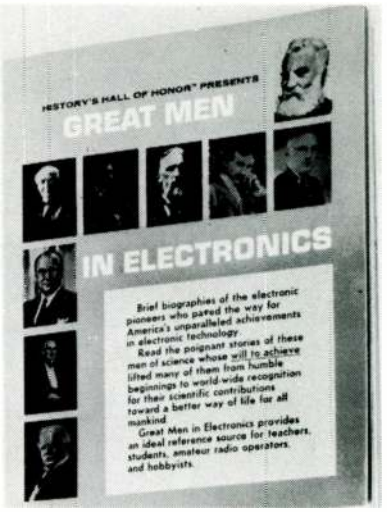

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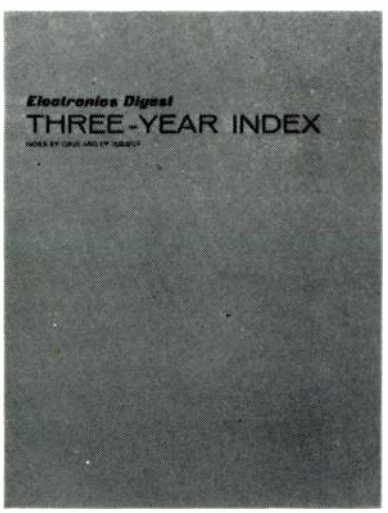

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