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TELEVISION NOSTALGIA . . .

25 years of memories!

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Job Opportunities in the 70s

"Eight out of ten jobs to be filled during the 1970s will be open to people who have not completed four years of college."

(See Page 7)

Electronics Digest®

AMERICA'S MOST INFORMATIVE ELECTRONICS MAGAZINE

A TANDY CORPORATION COMPANY

Volume Six / Number Two **September / October 1972**

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Television Nostalgia: 25 Years of Memories

This year marks the 25th anniversary of television – a quarter century of dramatic progress from an uncertain infancy to a position of worldwide importance

Special Report

This year marks the 25th anniversary of television – a quarter century of dramatic progress from an uncertain infancy to a position of worldwide importance. Although there were crude forms of televised communications in the 1920's, it wasn't until the postwar years that technology had progressed far enough to manufacture TV systems at reasonable prices.

TV networks that bring us much of today's TV news and entertainment began on a rather small scale a quarter century ago in 1947 with a relay cable from New York to Boston. One network expanded operations from New York to Baltimore and Washington while another chose Philadelphia, Schenectady and Washington. It was not uncommon for the networks to pool their resources for some shows.

As early programming began there was *Howdy Doody,* starring the famous freckle-faced puppet who first asked the Peanut Gallery, "Hey kids, what time is it?" in 1947. There were some live dramatic programs, like the *Kraft Theatre.* And anyone over 30 remembers wrestling and the roller derby. Antonino Rocca, Gorgeous George, and Tuffy Brasuhn were TV sports stars when Joe Namath was still playing sandlot football. Then, of course, there was "Uncle Miltie," Milton Berle, who brought the fledgling medium to new heights of popularity. Berle's antics in outlandish costumes were featured on the *Texaco Star Theater,* premiering in 1948. Ed Sullivan's "really big shew" began in that year, too; its vaudeville format and nervous, thick-tongued host would remain TV fixtures for 23 years.

America did not take long to become addicted to its new toy. In 1947, 179 thousand TV sets were in use in the country; five years later the number was 22 million. In 1972, twenty-five years later, television sets are found in over 95 percent of American households. The second-TV set home is fast becoming the rule rather than the exception. TV created a mass audience and quickly displaced radio and the movies as the nation's prime medium for information and entertainment.

In programming, some formulas were established early and survive to the present as TV staples. One of these formats is the situation comedy. Lucille Ball first started whining "Now, Ricky-y-y!" to husband Desi Arnaz in 1951 and has kept up her antics to the present as one of the longest-surviving stars. *I Love Lucy* set the pattern for countless "sitcoms" to follow, though none was as successful as the original. Most were family-oriented, in endless variations involving talking cars, talking horses, genies, witches, chimpanzees, and others. Another winning formula has been the action show, most involving cops and robbers and detectives, but in some variations spies, photographers, newspaper reporters, undercover agents, soldiers, and even one with a public relations agent! *Dragnet,* with Jack

(Continued on next page)

(Continued from preceding page)

Webb as Sgt. Joe Friday, Badge 714 of the Los Angeles Police Dept., recounted details of actual crimes, the names being "changed to protect the innocent." *Peter Gunn, Richard Diamond, 77 Sunset Strip* were popular detective show variations. In the early 1960's *The Untouchables,* the series about gangland crime in the Prohibition era, skyrocketed up the ratings list. In the later 1960's spy shows were the rage – *The Man From U. N. C. L. E.*, with Robert Vaughn, was a tongue-in-cheek spoof, as was *I Spy,* featuring Robert Culp and Bill Cosby as American agents travelling around the world.

In the mid-1950's the so-called "adult Western" quickly became popular. In this kind of show heroes did less shooting and more emoting than in the old Gene Autry-type Western. The "adults" offered messages about brotherhood and family values. *Gunsmoke,* with Jim Arness as Sheriff Matt Dillon has been a big favorite from its start in 1955. Another favorite was *Cheyenne,* starring Clint Walker, which marked the entry of the big movie studios into TV production in 1955. It soon had many imitators. Along with *Gunsmoke, Bonanza,* a family-oriented series about the patriarch of the Ponderosa, starring Lorne Greene as Ben Cartwright, has remained a ratings favorite from 1959 into the 1970's.

There were some things on TV peculiar to the 1950's alone. There was live, original comedy, insane and brilliant: Sid Caesar's *Your Show of Shows,* with Imogene Coca and Carl Reiner, satirizing movies, operas and people, and Ernie Kovacs with inventive camera techniques to present his low-keyed wild comedy.

The mid-1950's was also a period of many live dramatic shows – *Playhouse 90, United States Steel Hour, Studio One, Omnibus, Kraft Television Theatre, Hallmark Hall of Fame.* They produced great shows, like Rod Serling's *Requiem for a Heavyweight* and Paddy Chayefsky's *Marty,* before they became movies. There were also such greats as *Amahl and the Night Visitors, The Green Pastures, Little Moon of Albans* and *A Night to Remember,* which re-enacted the sinking of the ship Titanic, using 31 sets.

Much TV nostalgia involves the quiz shows, like Groucho Marx' *You Bet Your Life,* where Groucho enticed guests with a $100 prize (delivered by a mustachioed fake duck lowered from the ceiling) for saying the "secret word." You could tell sob stories and win big on *Strike It Rich,* with Warren Hull, where people across the country would phone to offer the story-telling contestant money. You could win a mink coat on *The Big Payoff.* You could win a lot more than that on *The Price Is Right,* with Bill Cullen, if you were successful in bidding for gifts while a frenzied audience yelled "higher" and "freeze."

Then there were the big-money quizes – *$64,000 Question, Twenty-One,* and others – where week after week contestants like Charles van Doren and Elfrida von Nardroff would sweat and twitch and win hundreds of thousands of dollars – until it was found out the shows were rigged, precipitating Congressional investigations.

People actually used to get married on TV, Monday through Friday, on *Bride and Groom.* Real surgical operations appeared on *Medic,* starring Richard Boone as Dr. Konrad Styner; they even showed a baby being born on one show. Real lawyers interrogated actors on the live, unrehearsed episodes of *The Verdict Is Yours,* emceed by Jim McKay. Reporters questioned "great historical figures" on *You Are There,* which re-enacted such things as the assassination of Julius Caesar and the Chicago Fire.

Dave Garroway, famous for his uplifted palm and "peace" salutation, left his mark as the first popular easy-going talk show host, while Jack Paar proved a sensitive, high-strung host could also draw a devoted audience. Singer Dinah Shore was the epitome of bouncy vivacity symbolized by her "mmwah" kiss at show's end, while Perry Como crooning "Dream Along With Me" was an example of the relaxed intimacy TV encouraged. The gang on *Your Hit Parade* managed to carry over their show from radio and present popular songs of the 1950's in a new form each week. Edward R. Murrow each week went "live" by TV camera into the homes of personalities such as Marilyn Monroe on *Person To Person.* And of course when Jimmy Durante walked off that spotlit stage, he always said, "Goodnight, Mrs. Calabash, wherever you are."

Television introduced the American public to the age of special documentaries along with "live" coverage of events of historical importance. There was the stirring 26-part documentary, *Victory at Sea,* featuring the original musical score by Richard Rogers.

On the historical side was the full coverage by the networks of circumstances surrounding the assassination of President Kennedy, and the somber ceremonies of his funeral. Also of tremendous historical import was the "live" coverage of America's first-man-on-the-moon mission of Astronauts Neil Armstrong and Edwin Aldrin, including the conversation between the astronauts and President Richard M. Nixon, who was speaking from the White House in Washington, D. C.

Another history-making event covered by "live" television was the unprecedented visit to the Peoples Republic of China. Millions of Americans, as well as countless numbers of people in other parts of the world who were also able to watch the event via Intelsat communications satellite, participated in a new experience in people-to-people contact in international relations. It was a bold, progressive step toward better understanding and peaceful relations between people of the earth.

Since its beginning, television, like the print media, has not escaped criticism. In the minds of many people it has logged an impressive list of presentations of unquestioned merit, but they may also find fault with some of the television programming and coverage of special events as exhibiting excessive bias. Among television's most outspoken critics in this sector in recent times, we remember the name of our Vice President Spiro Agnew, who ostensibly has spoken up for the "silent majority."

In spite of its often rocky road television, after a quarter-century, remains a strong, promising medium of communication with the masses. Its popularity cannot be denied! And its influence for good or for bad is a formidable force to be reckoned with in the years ahead.

Highlights of some of TV's memories will be featured in a 90-minute TV special, "Zenith Presents a Salute to Television's 25th Anniversary," to be aired Sunday, September 10, on ABC-TV (9:30 p.m. EDT), sponsored by Zenith Radio Corporation. The show will feature tapes and kinescopes of memorable moments in TV and re-creations of famous programs with many top TV stars.

Job Prospects in the 1970's

New 1972-73 edition of Labor Department Handbook reports needs and requirements of more than 800 occupations and 30 major industries

The new 1972-73 edition of the *Occupational Outlook Handbook*, the Government's encyclopedia of employment information designed to help young people choose careers, was recently released by the Bureau of Labor Statistics. The revised and updated 850-page volume reports on job needs and prospects through the 1970's for more than 800 occupations and 30 major industries and reflects the effects of new technology and changing economic conditions. Each job discussion in the *Handbook* covers the nature of the work, the training and education required, places of employment, earnings and working conditions, and the employment outlook to 1980. Reassessments of employment conditions which may develop between biennial editions of the *Handbook* are published by the Bureau of Statistics in a supplement, *Occupational Outlook Quarterly*.

According to Labor Secretary J. D. Hodgson – basing his comments on the data compiled for the *Handbook* – "Eight out of ten jobs to be filled during the 1970's will be open to people who have not completed four years of college." But, he adds, "more job training will be required of young people in the 1970's as industrial processes, technology and business procedures increase in complexity." These on-job training requirements will continue to rise and young people with vocationally-oriented education beyond high school will be in the best position to compete for openings.

Jobs in professional and managerial occupations will increasingly require a college degree. Even within this group, however, workers with only a year or two of specialized training beyond high school will find many excellent opportunities as aides and technicians.

Engineering is also a promising field, despite current employment difficulties for such workers. According to the new *Handbook*, "Engineering has been one of the fastest growing professions in recent years, and needs for these workers are expected to increase rapidly during the 1970's, although at a slower rate than during the 1960's." Demand is expected to be particularly strong for engineers specializing in computer applications and for those who can apply engineering principles to medicine, biology and other sciences.

The following partial summary of expected annual job openings during the 1970's for selected occupations is based upon information from the *Occupational Outlook Handbook*. The annual openings cited are averages for the 10-year period, estimated on the basis of long-term growth and replacement needs. The actual number of openings in any one year may differ from the number given, depending on business conditions as a whole. Assessments of competition for jobs are based on a projection of recent trends in the number of persons who choose training for each occupation.

PROFESSIONAL AND MANAGERIAL OCCUPATIONS

SCIENTIFIC AND TECHNICAL OCCUPATIONS

Engineers – 1970 Employment, 1.1 million; Annual Openings, 58,000. Generally favorable employment opportunities through the 1970's in this, the largest field of professional employment for men. However, rapidly changing technology and shifts in national priorities may affect adversely those who are overly specialized or not well grounded in fundamentals.

Physicists – 1970 Employment, 48,000; Annual Openings, 3,500. Favorable opportunities, especially for those having advanced degrees to conduct research and teach.

Life Scientists – 1970 Employment, 180,000; Annual Openings, 9,900. Rapid increase in employment, especially in research related to health and environmental problems, through the 1970's. However, the number of life science graduates is expected to increase rapidly, resulting in keen competition for the more desirable positions.

Environmental Scientists – 1970 Employment, 40,800 (geologists, 23,000; geophysicists, 8,000; meteorologists, 4,400; oceanographers, 5,400); Annual Openings, 1,500. Favorable opportunities, especially for Ph. D. degree holders for research work. Opportunities will be most favorable for geophysicists.

Engineering and Science Technicians – 1970 Employment, 650,000; Annual Openings, 33,000. Favorable opportunities. Demand strongest for graduates of post-secondary technician training schools to fill more responsible jobs. Industrial expansion and complexity of products and manufacturing processes will increase demand.

Radiologic Technologists – 1970 Employment, 80,000; Annual Openings, 7,700. Very good full-time and part-time employment opportunities as use of X-ray equipment in the diagnosis and treatment of disease expands.

CLERICAL OCCUPATIONS

Electronic Computer Operating Personnel – 1970 Employment, 200,000; Annual Openings, 34,200. Employment is expected to increase very rapidly as computers are adapted to new uses.

CRAFTSMEN

Television and Radio Service Technicians – 1970 Employment, 132,000; Annual Openings, 4,500. Rapid increase in employment related to growing number of television, radios, phonographs, and other consumer electronic products.

OCCUPATIONAL OUTLOOK HANDBOOK

The Occupational Outlook Handbook ($6.25) and its supplement, the Occupational Outlook Quarterly ($3 for a 2-year subscription), may be purchased from any of the regional offices of the Bureau of Labor Statistics listed below. (Make checks or money orders payable to the Superintendent of Documents.)

1603-A Federal Building
Boston, Massachusetts 02203

341 Ninth Avenue
New York, New York 10001

406 Penn Square Building
1317 Filbert Street
Philadelphia, Pennsylvania 19107

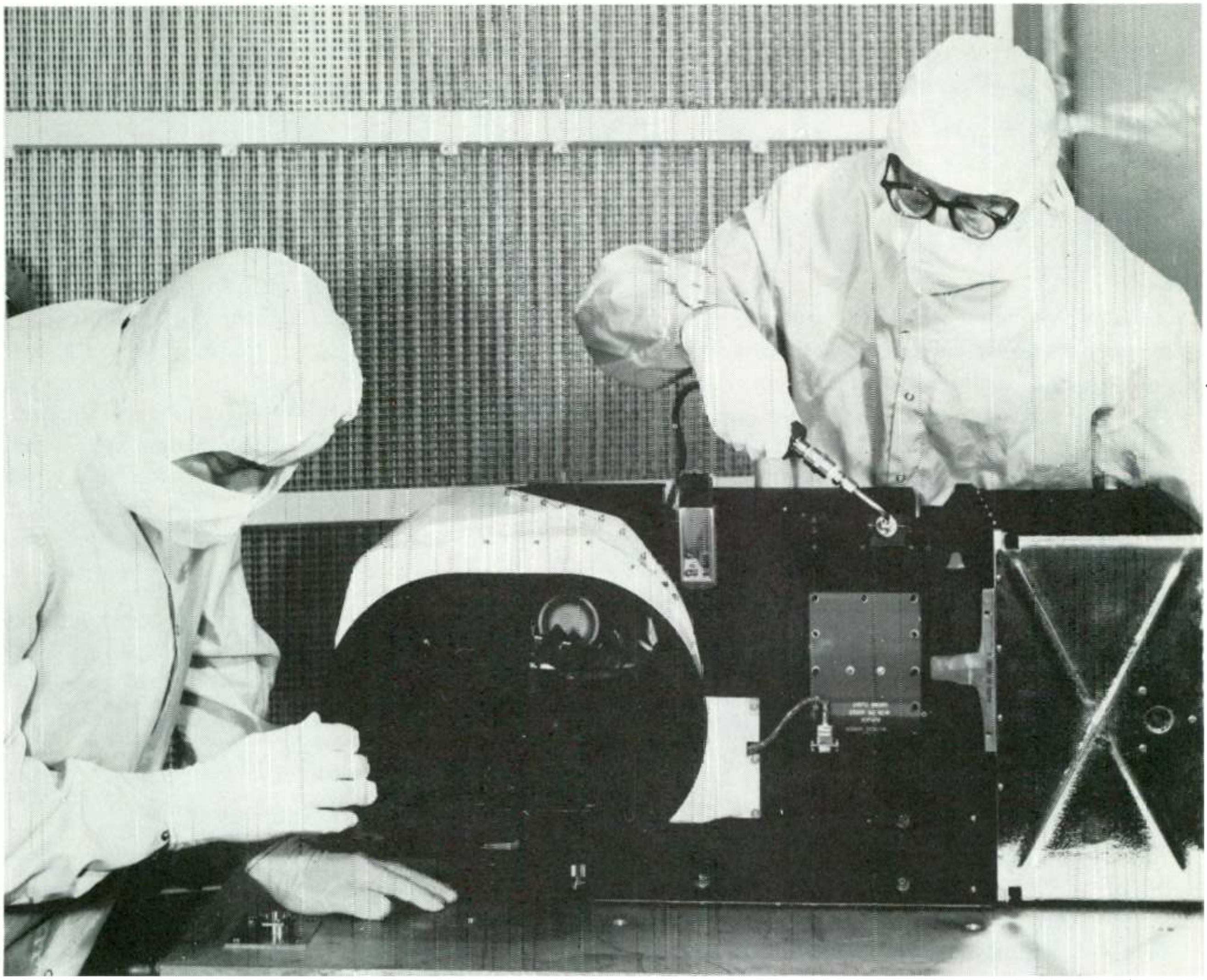
1371 Peachtree Street, N.E.
Atlanta, Georgia 30309

300 South Wacker Drive
Chicago, Illinois 60606

911 Walnut Street
Kansas City, Missouri 64106

1100 Commerce Street
Dallas, Texas 75202

450 Golden Gate Avenue
Box 36017
San Francisco, California 94102



Courtesy Hughes Aircraft Company

EYE ON EARTH – A Multispectral Scanner System (MSS) is put through a nitrogen-purging operation to ensure internal cleanliness by George Barton (left) and William Francis, engineers at Hughes Aircraft Company, El Segundo, Calif., where the system was developed for NASA's Goddard Space Flight Center. Shown is a back-up flight model, identical to the system aboard the Earth Resources Technology Satellite (ERTS-A) scheduled for launch from the Western Test Range near Lompoc, Calif. (July 21).

Space-Orbiting Sensor Monitors Earth's Health

A new space-orbiting scanning device captures light waves from Earth to provide environmental scientists with data concerning the effects of nature and mankind on the nation's natural resources

A space-orbiting scanning device, which will capture light waves from Earth to show environmental scientists what nature and mankind may be doing to the nation's natural resources, will be one of the major sensing systems aboard a new NASA satellite launched from the Western Test Range near Lompoc, California July 21.

The scanner, which is called MSS (for Multispectral Scanner System), will detect and record solar energy emitted or reflected from Earth in four bands of the electromagnetic spectrum, including near infrared, to produce photographs that will indicate whether Earth's resources are healthy or not.

The Earth-scanning sensor was developed for NASA's Goddard Space Flight Center, Greenbelt, Md., by Hughes Aircraft Company's space and

(Continued on next page)

communications group and the company's subsidiary, Santa Barbara Research Center.

As a major segment of the sensing payload carried aboard the new ERTS-A (Earth Resources Technology Satellite), built by General Electric, the scanner will provide data to help safeguard vital resources such as rivers, lakes, forests, crops and mineral accumulations.

The 1965-pound satellite, which stands 10 feet high and resembles a huge butterfly, will be boosted into a 565-statute-mile-high sun-synchronous orbit by a Delta rocket. The spacecraft will circle Earth every 103 minutes, retracing its path over the same spot on Earth at the same local time every 18 days.

The MSS data will be transmitted in real time as the satellite passes over ground stations located in Goldstone, Calif., Greenbelt, Md., and Fairbanks, Alaska,or it may be stored in on-board tape recorders for delayed transmission.

MSS data received at the ground stations will be relayed to the NASA data processing facility at Greenbelt, where the photographic images will be processed and produced for distribution to the user agencies and principal investigators. The MSS scanner is expected to produce about 9,000 pictures a week.

These will be available to ERTS-A users for general research in such areas as agriculture, forestry, geology, hydrology and oceanography. More than 300 investigators, each with a scientific experiment, the greatest number ever approved for a NASA program, will represent 44 states, the District of Columbia, and 35 foreign nations.

In addition to the MSS, the one-ton spacecraft will carry a three-camera vidicon system, similar to TV, which will produce triple simultaneous views of the same scene viewed by the scanner. The spacecraft also will have aboard a data collection system, which will receive and relay back to Earth signal inputs on eight different kinds of data from some 150 automated data-collecting playforms already distributed throughout the United States, Canada and Central America.

Dr. Ted Savo, Hughes MSS associate manager, said the scanner will have an operational ground resolution of better than 300 feet.

"This is like looking at a 1/3-inch square from about 100 yards away," he said.

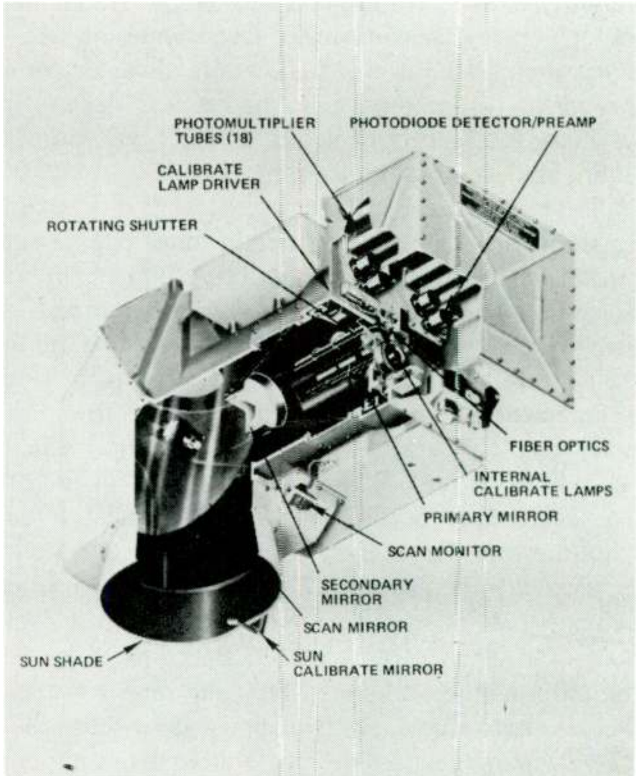
Early image analyses of photos will seek to establish the true solar energy "signature" emitted by each known resource. Once these have been obtained they will be used as benchmarks for future scannings of the same resource.

Spectral data will be converted into black and white and color composite photos. These can be examined by investigators to indicate the health of a given resource, or to determine the extent of damage that may have occurred in a particular crop or forest, for example, due to blight or insect infestation.

The solar emissions detected by the scanner will range in wavelengths from 0.5 to 1.1 microns (1 micron is about 1/3 millionth of an inch). These extremely small wavelengths will be reflected into an optical system by the scanner's oscillating mirror as it scans 115-statute-mile-square areas of Earth.

Copies of all ERTS data and photos produced by the Goddard data processing facility will be sent to the Department of Interior's earth resources data center in Sioux Falls, South Dakota.

Eight states will use the satellite data for highway building, urban development and agricultural planning – California, Alaska, Alabama, Arizona, Maryland, Ohio, Oregon and Washington.



Hughes Aircraft Company

CUTAWAY VIEW shows the Multispectral Scanning System (MSS), which will be one of the sensing payloads aboard the NASA/GE Earth Resources Technology Satellite (ERTS-A) scheduled to be launched from the Western Test Range near Lompoc, Calif. (July 21). The system was developed by Hughes Aircraft Company's space and communications group and the Santa Barbara Research Center, a Hughes subsidiary, for NASA's Goddard Space Flight Center.

High Frequency Phonons: A New Research Tool

Bell Labs new technique for generating and fine tuning phonons to the thermal frequency range opens new avenues of study

Scientists at Bell Laboratories have devised a technique for generating and tuning sound waves called phonons in narrow frequency bands as high as four hundred billion cycles per second, about one hundred times higher than previously attained and tens of millions of times higher than frequencies audible to the human ear. Phonons are packets of sound energy vibrating through a solid. At these high frequencies, the sound packets will be useful for studying certain atomic properties of solids which thus far have been difficult to probe. A narrow beam of high frequency phonon pulses can be used to study materials just as beams of light, x-rays, neutrons or electrons have been used. The way the material reacts to the beam gives researchers information about its nature. Since materials react differently to different kinds of beams, the availability of high energy phonons opens new avenues of study. Phonons may be useful for investigating electronic properties of materials; impurities and defects in crystals; interaction of acoustic vibrations within a solid; and phonon decay properties.

The phonon generating device consists of a heater, in the form of an alloyed metal film of copper and nickel, near a thin superconducting film of tin but separated from it by a thin layer of electrical insulator. The tin film is attached to the material being studied and is sealed inside a cryostat (low temperature chamber), which is used to lower the operating temperature to 1.3° Kelvin (more than 450° F below zero). The heater is turned on and off to create heat pulses. Each pulse of heat forces phonons into the superconductor. A superconductor is a metal which loses all its electrical resistance when cooled to an extremely low temperature. This loss of resistance results from electrons becoming bound together in pairs. The phonons from the heater break these electron pairs apart, but when the electrons recombine they emit another phonon of a particular energy which is equal to the binding energy of the electron pair. Thus the breaking and recombination of pairs of electrons generates a narrow band of high frequency phonons. By varying a controlled magnetic field parallel to the thin film superconductor, Bell Lab scientists can change the frequency of the phonons being produced.

Additional Technical Information

The idea that superconducting tunnel junctions could be used to generate high frequency acoustic waves was proposed several years ago by Bell Labs scientists. Later experiments demonstrated that such junctions could be used to generate milliwatts of phonon power over a very restricted spectrum and that the technique could be used to provide an essentially monochromatic source of phonons by detecting a small portion of the phonon distribution. Recent experiments showed that a simpler method, using a thin film Constantan heater adjacent to a superconductor instead of the tunnel junctions, can be used for generation of phonons and that the application of a magnetic field up to one kilogauss can

(Continued on next page)

Photo Courtesy Bell Labs

PHONON MAKERS – Dr. Robert C. Dynes and Dr. Venky Narayanamurti of Bell Labs, who have devised a new technique for generating and tuning unusually high frequency phonons, lower a wired sapphire crystal into a cryostat, where at 450° F. below zero, the crystal sample will be probed by a narrow beam of high frequency phonon pulses.

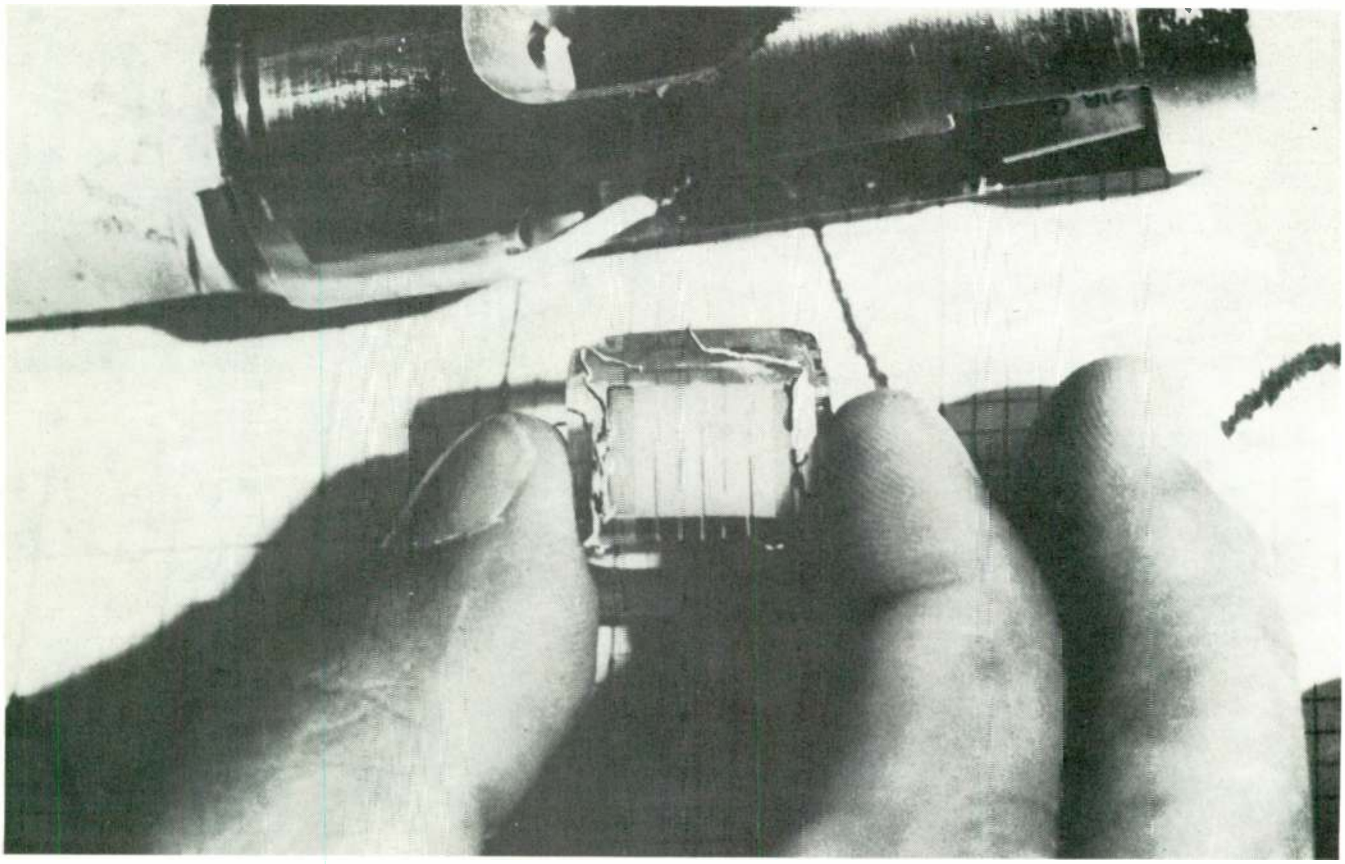


Photo Courtesy Bell Labs

WIRED FOR SOUND – Certain atomic properties of this sapphire crystal can be studied using a new Bell Labs technique for generating and tuning high frequency sound waves called phonons. The crystal is attached to a thin film heater for generating phonons and a superconducting film of tin. It is wired into the sample holder (top) and sealed in a cryostat, where it is bombarded by phonons at more than 450° F. below zero.

HIGH FREQUENCY PHONONS
(Continued from preceding page)

be used to tune the emitted phonon frequency over a wide range.

Heater temperatures of about 5° Kelvin are used to force phonons into the superconductor. At superconducting temperatures the superconductor develops an energy gap, whose magnitude is called "2-delta." This energy gap for different materials extends, typically, from 0.2 to 4.0 milli-electron volts. Phonons with energy of less than 2-delta pass through the superconductor. A phonon of greater than 2-delta energy excites a pair of electrons up to the energy gap or higher. As this excited pair of electrons loses energy again, it produces phonons of 2-delta or less. As phonons of any energy are added to the superconductor, a large number of 2-delta phonons emerge from the other side, with up to hundreds of milliwatts of power.

A magnetic field applied parallel to the thin film superconductor is used to tune the energy of the phonons emitted. The energy gap of the superconducting electrons decreases uniformly as the magnetic field is increased. Therefore, phonon frequencies can be changed by varying the magnetic field. In superconducting tin, for example, phonons can be tuned from about 2.8×10^{11} to 1.5×10^{11} Hertz. Researchers expect to be able to produce phonon frequencies from about 5×10^{10} to 10^{12} Hertz by experimenting with different superconducting materials and tuning each one They may be able to generate phonon powers of more than a watt by this technique.

The tunability and high power level of the phonon generator is expected to make it practical for use for phonon spectroscopy in a previously inaccessible frequency range (in the thermal frequencies). It has been used already to observe the ground state splitting of Vanadium impurity ions (V^{3+}) in sapphire (Al_2O_3).

To detect phonons the scientists use a second superconductor, functioning in a complementary way to the one in the phonon generator. They also make use of a property of an antimony doped germanium crystal: the antimony can be tuned by squeezing the crystal to a value corresponding to the superconduction energy gap. The crystal can be made to absorb phonons of only a particular frequency, and this is detected through a decrease of the observed signal.

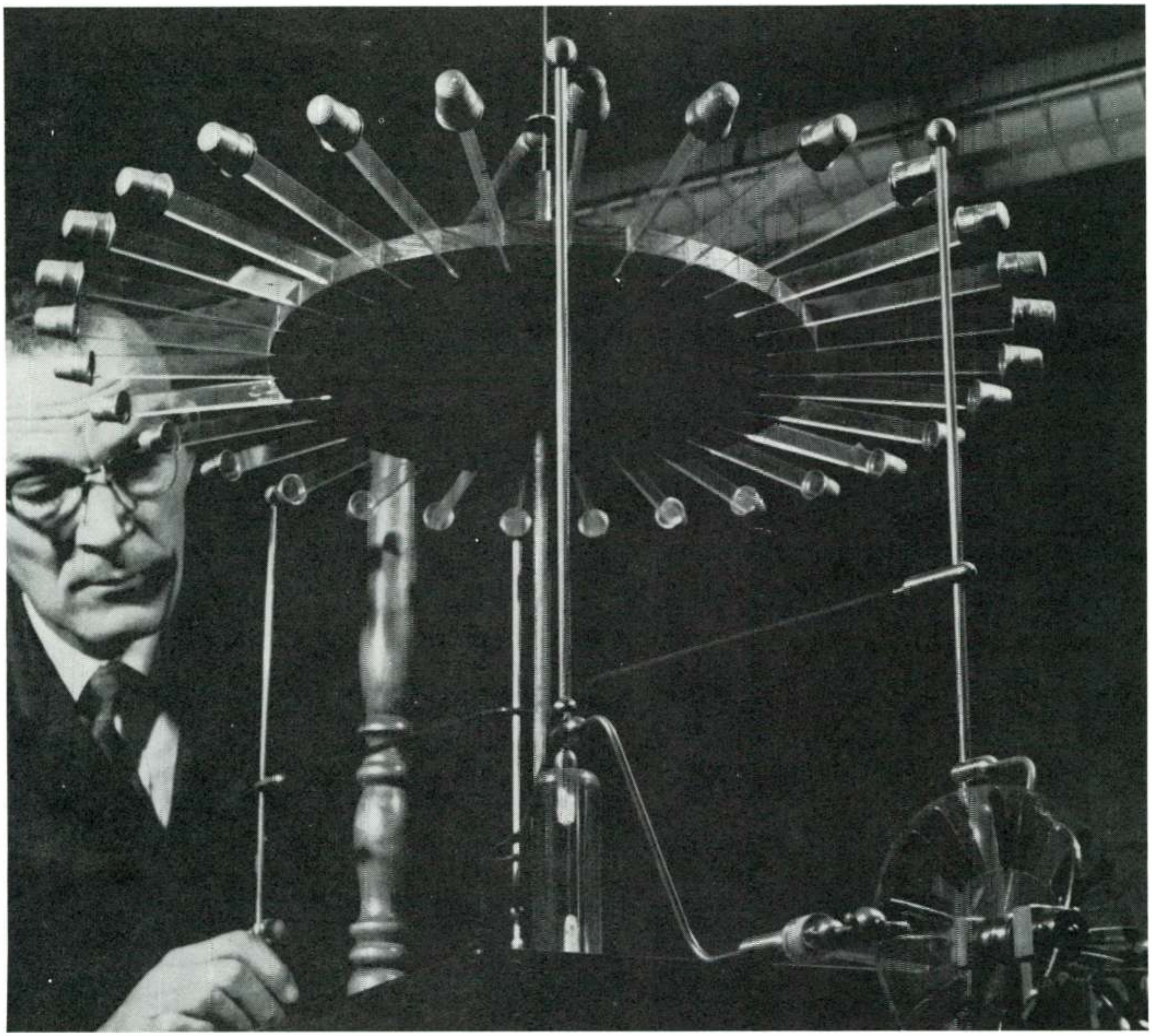


Photo courtesy West Virginia University

Except for unimportant changes in materials used and modern Leyden jars, the motor made by Okey M. Cogar at West Virginia University is an exact replica of Franklin's motor.

Ben Franklin: Early-American Genius in Electricity

The Russians may have invented fire, but good old Ben Franklin invented the first electric rotisserie and the first electric motor – and they work, according to scientists at West Virginia University

The electric motor and the electric rotisserie are not inventions generally attributed to Ben Franklin, who was born on January 17, 1706, in Boston, Massachusetts. But Okey M. Cogar, research associate in the Department of Physics at West Virginia University, recently proved that Franklin's instructions for constructing an electric motor really work. Out of sheer delight in doing things, Cogar (with the help of Dr. Oleg Jefimenko, WVU professor of physics) decided to build an electric motor according to Franklin's instructions.

"It didn't surprise me that the motor worked, but it is surprising that it took over 100 years before anyone found any practical use for an electric motor—and of course the fellow built his motor on an entirely different principle from that used by Franklin," Cogar said.

Franklin's motor, which he called an electric

(Continued on next page)

jack, is based on the principles of static electricity and was described by him in a letter written in 1748. Michael Faraday, who is generally given credit for inventing the first electric motor, is reported to have studied Franklin's book, "Experiments and Observations on Electricity."

Faraday's motor, which is based on the principles of electromagnetism and is the type that is commonly used today, was first built in the early 1830's. His discovery, which may sound simple but has changed man's way of life, was that a copper disk would rotate when placed between two magnets.

The first practical electromagnetic motor was developed on Faraday's model by Thomas Davenport, a New England blacksmith, who used it to drive a drill press. Davenport's motor, which was patented in 1837, was powered by three chemical cells (batteries).

Franklin's motor consisted of a horizontal wooden disk 12 inches in diameter fitted with 30 narrow strips of glass with brass thimbles on the ends. This "electric wheel" rotated on a vertical wooden shaft that had an iron point at its lower end and a wire extending from the upper end. The wire was passed through a small hole in a thin brass plate to keep the shaft vertical.

The motor was powered by condensers (Leyden jars). Leyden jars in Franklin's time were widemouthed bottles full of water and coated on the outside with metal foil. A metal hook was passed through the cork and submerged in the water. The jars were charged by mechanically turning a glass globe and rubbing it with a piece of buckskin. The charges were picked up from the globe and transferred by a wire to the hook or the metal foil of the jar.

The simplest form of the motor consisted of the electric wheel and two oppositely charged Leyden jars placed 180 degrees apart. As each thimble approached the hook of the first jar, it would receive a spark (like charges of electricity repel each other and unlike charges attract). Now that the thimble and the hook had the same charge, the thimble was repelled and caused the wheel to turn. As that thimble approached the second jar, it was attracted and added this force to turning the wheel. But because the charge on the second jar was much greater than that on the thimble, a spark opposite in charge to the first spark would pass from the thimble to the second hook and thus give the thimble and the second hook the same charge. This caused the thimble to be repelled from the second jar and attracted by the first jar.

According to Franklin, he was able to make such a wheel turn at from 12 to 15 rpm and placing 100 Spanish dollars (about the size of our silver dollar) on it didn't slow it down.

Except for unimportant changes in the materials used and the use of modern Leyden jars, the motor made by Cogar is an exact replica of Franklin's motor.

STATIC ELECTRICITY

"Static electricity is one of the least exploited fields in science," according to Dr. Arthur S. Pavlovic, chairman of the WVU Department of Physics. "This also means that it's one of the most promising, and it's hoped that some contributions will come from the work being done at WVU. Dr. Jefimenko and his graduate student, Henry Fischbach of Puerto Rico, are investigating a high-voltage, direct-current motor that looks very promising."

The term "static electricity" is, in a way, a misnomer for what can perhaps best be thought of as pulses of direct current. One of the characteristics of static electricity is extremely high voltages. Cogar has built a small (about four inches in diameter and one inch thick) electrostatic generator that operates at about 70,000 volts. (This generator can also be used as a source of power for Franklin's electric wheel.) Such voltages are extremely dangerous and are one of the reasons that few static electric devices were developed in the old days. Another reason is that the only practical insulator for such voltages was mica— and mica is still very expensive.

"We are learning how to handle these high voltages and modern plastics have eliminated the mica problem," Dr. Pavlovic observed. "The fact that mica was so expensive and copper was fairly cheap has had a great influence on electrical technology. Today copper is expensive and the plastics that have replaced mica are fairly cheap. This is going to have an affect on future developments in electricity.

A "FIRST-RATE SCIENTIST"

Because of Franklin's numerous accomplishments in diplomacy and other fields, many people don't realize that he was also a first-rate scientist, Cogar maintains. "He not only invented the Franklin stove and the lightning rod, but made several important contributions to electrical theory. He proved that the positive and negative charges on a condenser are equal, and he was one of the foremost advocates of the theory that there are two kinds of electricity—positive and negative. He coined the terms 'positive' and 'negative' as applied to electricity and was the first to use the + and — signs." Furthermore, Cogar explained, "he also showed that static electricity is attracted to and discharged from pointed bodies more readily than curved bodies. The lightning rod was an application of this principle."

METEOROLOGY

Photo Courtesy Hughes Aircraft

TWO 8-FOOT-DIAMETER RECEIVE AND TRANSMIT ANTENNAS at each of several small ground stations – part of Hughes' new TRRR system – will determine the exact position in space of a synchronous satellite orbiting at 22,300 miles above the equator.

Ranging system for cloud watch

Field tests recently began on a new ranging system that will help gather more accurate information on the movement of cloud formations and their affects on weather conditions. Trilateration Range and Range Rate (TRRR) was developed by Hughes Aircraft Company for NASA's Goddard Space Flight Center and will be used with the series of Synchronous Meteorological Satellites scheduled for launch in 1973.

In operation, a master ground station at Wallops Island, Virginia, will transmit a signal tone to a satellite at regular intervals. The tone will be relayed via the satellite to two unmanned miniaturized earth stations, which under present Goddard plans will be located in San Francisco, California, and Santiago, Chile. The unmanned stations, about twice as big as a telephone booth, are equipped with dual antennas, eight feet in diameter, for reception and transmission of the ranging signal. Measurement of the elapsed time it takes for the control signal to be received and bounced back from the widely separated stations enables ground controllers to pinpoint the exact position in space of a synchronous satellite orbiting at 22,300 miles above the equator. By comparing the data received from the stations with the known resolution of the satellite's on-board camera system, which will make successive still pictures of cloud formations, meteorologists will be able to calculate the speed of the cloud formations and their potential affect on weather conditions. The pictures can be processed into time-lapse motion pictures that compress a day's weather into a few seconds. By projecting these, meteorologists can study the formation, speed and direction of the clouds and create a mathematical model of the process to help provide accurate long-range weather forecasts.

Tests of the system will be conducted with the Hughes-built Applications Technology Satellite ATS-1, which was launched into synchronous orbit above the Pacific in December 1966. The first satellite in the SMS series scheduled for launch October 1973 will be stationed at approximately 95 degrees west longitude, directly south of the central United States.

Radar maps storm winds at sea

Although the potential for the use of high frequency (HF) radar for oceanographic and meteorologic study has been demonstrated over the past decade, actual implementation of techniques has not been effected. Naval Research Laboratory (NRL) scientists in Washington now believe they have developed a key method for operational HF radar techniques: NRL radar men say the short time response of the sea surface to local winds may be mapped by the analysis of a matrix of range-azimuth records containing frequency power spectra of HF radar signals backscattered from the sea surface via the ionosphere; they are demonstrating the technique by mapping North Atlantic storm winds at long range (500 to 1000 nautical miles) from the Laboratory's HF radar research facilities at Chesapeake Beach, Maryland. Controlled experiments in this field continue; among these: the measure of backscatter parameters as a function of radar frequency, angle to the wind, and detailed time-dependent sea surface spectral characteristics. When the HF backscatter spectrum can be confidently related to the spectral characteristics of the sea, NRL investigators say HF radar will provide a powerful tool for studying the detailed morphology of the sea surface.

OCEANOLOGY

Ocean program recommended

In a new 255-page report, "Toward Fulfillment of a National Ocean Commitment" ($4.95, from the Printing and Publishing Office, 2101 Constitution Avenue, N.W., Washington, D. C. 20418),

(Continued on page 31)

Special Feature Pull-Out Section

Old-Time Radio T.M.

HISTORICAL EVENTS IN ELECTRONICS

Edited by
William M. Palmer, W5SFE

- BIOGRAPHICAL SKETCHES OF GREAT MEN
- HISTORY OF INVENTION
- PICTORIAL HISTORY OF ELECTRONICS
- OLD-TIME RADIO PROJECTS
- NEWS OF HISTORICAL INTEREST

The human mind is sleepless in the pursuit of knowledge. It is ever seeking new fields of conquest. It must advance; with it, standing still is the precursor of defeat.

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

Published by

Electronics Digest

1024 Currie Street, Fort Worth, TX 76107

yesterday & today

NEWS OF HISTORICAL INTEREST

Ten years since Telstar – a new era in communications

Ten years ago today a small satellite was lifted into space, carrying with it the beginnings of a new era in communications. Dubbed the Telstar satellite, it set the stage for the future by conveying the first television broadcast between the United States and Europe.

Headlined in Paris as "Le Miracle Telstar" and in London as a "tele-Victory," the historic telecast viewed simultaneously by Americans and Europeans featured the Stars and Stripes rippling gently in front of the satellite's earth station in Andover, Maine.

The Telstar project designed, built and paid for by the Bell System, is credited with making a significant contribution towards today's international communications technology.

Within hours of the launch Telstar successfully relayed television, voice, data and facsimile in an historic demonstration of the practicability of communications satellites.

During the early weeks of the experiment a number of historic satellite firsts were scored. These included: taped and live television from Europe; color and two-way TV tests; two-way telephony between New York and Paris; transmission of a variety of digital data; and transmission of high-speed, two-tone facsimile copy.

In addition to the communications experiments the Telstar satellite carried instruments which gave valuable information about the effect of the space environment on satellites. Later, Telstar helped to verify the existence of Van Allen radiation belts surrounding the earth.

Now, ocean-spanning television broadcasts "Via satellite" are almost commonplace. In February, Americans watched President Nixon toast Chou En Lai in Peking's Great Hall of the People, live and in color. Sports fans watched the world's greatest athletes perform live from the 1972 Winter Olympics in Japan. And probably the most awe-inspired scene of these times – man's first step on the moon – was beamed instantaneously via satellite to homes throughout the world once the signal was received by Apollo Project's terrestrial network.

Today's satellites play an integral part in America's overseas communications, providing almost half of the telephone circuits linking the United States to the rest of the world.

AT&T's Long Lines Department, the Bell System unit for interstate and international services, is the world's largest user of satellite circuits. Long Lines leases the circuits from the Communications Satellite Corporation (Comsat), created by Congress under private ownership in 1962 to handle America's overseas satellite facilities.

The Telstar satellite has been silent since 1963. But it is expected to continue orbiting the earth for another 200 years. Already it has spun around the globe some 34,000 times.

The satellite, designed by Bell Laboratories, the research and development unit of the Bell System, weighed only 170 pounds and was powered by nickel-cadmium batteries, recharged by 3,600 solar cells. It contained more than 1,000 transistors. Both the solar cell and the transistor were invented by Bell Labs.

In the satellite was a special, highly-reliable traveling wave tube to amplify signals received from earth.

The Telstar satellite was placed in orbit by Thor-Delta rockets guided by a Bell Laboratories/Western Electric radio-controlled guidance system.

Several key people who worked on the project recall the day of the Telstar launch: Robert Latter, an engineering director at AT&T, remembers rising before the 4:30 a.m. blastoff to turn on the electronic equipment he had assembled in his basement.

"I was anxious to see if the launch was a success," Latter recalls today, "and I knew if I could pick up the VHF tracking signal from the satellite on its first orbit, then we'd be in good shape."

Latter was rewarded. Because of the satellite's path on its first orbit he was able to receive the signal at his New Jersey home even before it was picked up on the giant horn antenna at Andover.

(Continued on next page)

Photo Courtesy Bell Laboratories

"THEY'RE RECEIVING US IN EUROPE." Learning that the taped TV talk by Frederick R. Kappel, then AT&T Chairman (on monitoring screen in background) has been successfully relayed by the Telstar satellite to France. Eugene F. O'Neill displays the traditional "thumbs up" for success. O'Neill was Director, Satellite Communications Laboratory at Bell Labs, when transmission was made from the Bell System's ground station at Andover, Maine on July 10, 1962.

Eugene F. O'Neill, executive director, Toll Transmission Division, Bell Laboratories, remembers the suspense of that day well.

"At Andover we had heard, of course, that the launch appeared to be perfect. However, the orbit was such that the satellite was not accessible to the ground station for over 12 hours after the launch. All day reports trickled in from tracking stations around the world that all was going well, but it was still an anxious moment when Telstar finally rose above our horizon in Maine. Within minutes we had locked our antennas to its tracking beacon and transmitted the commands to turn on the broadband amplifier. It was only when those first voice signals finally came through and the pictures appeared on our TV monitors that we could all breathe again."

AT&T Long Lines' vice president for engineering implementation, Robert E. Sageman, was satellite projects engineer in 1962. He remembers that there was great confidence in the satellite. "We had tested the Telstar satellite in simulations of every conceivable space environment," he says, "and we knew it would stand up."

Have old radio? Will trade!

If you have an old time radio, Dale Goodwin of Aurora, Colorado, is likely to show up on your front doorstep to make an offer. He says he'll travel anywhere for a good offer.

Months later, he may have that same set in mint condition and donate it to a museum or public benefit auction. Goodwin has some 200 vintage receivers — all Zenith's and most in original working condition.

Recently, he donated one of his prize mahogany table models with the distinctive big-black-round-dial to a Chicago educational TV station for auction. The $39.95 set of 1939 received a top bid of $526.

Goodwin also received a request from New York's Museum of Modern Art to display another "oldie" at an exhibit in South America and New York.

His longtime romance with pioneer radios began when his son purchased two ancient Zenith console radios at a farm auction. He now has more sets in his garage than many TV dealers have in their warehouses.

"The big-black-dial receivers manufactured in the late 1930's have been my favorites since childhood," Goodwin said. "The oldest set in my collection is a 3-R, manufactured by Zenith in 1922."

"Most of the radios I obtain are gifts from friends and relatives or purchases from Goodwill Industries, Salvation Army, Disabled American Veterans and surplus stores. I also watch miscellaneous sale ads in the newspapers. A collector must set a few ground rules," he said. "He must know the types of radios he wants to collect, the age range and the price he's willing to pay."

"I have one hard and fast rule — once I buy or trade for a Zenith, I will not sell or trade it off. I do consider a worthy donation."

Electronics is Dale Goodwin's life. It's his business at United Airlines as a jet flight simulator technician. He also once owned a radio repair shop. He still finds that a good home reference library is his best tool (along with a screw driver) to fully understand the circuitry of a pioneer radio. His library collection is extensive. It includes Zenith's service bulletins, schematic diagrams and line folders.

From the distaff side, Mrs. Goodwin is involved. She polishes the cabinets and acquires a prize item at a "flea market." Otherwise, she worries "about where I'll put all of Dale's purchases!"

"I arrange the radios in our garage so that they don't have to be moved. I line them along the wall, double deck, and cover them with a protective clear plastic. I also use only the top grade of furniture polish to keep the cabinet finish in good shape."

Courtesy Zenith Radio Corp.

Dale Goodwin of Aurora, Colorado, lead flight simulator technician at the United Air lines Denver Flight Center, donated this 1939 Zenith radio recently to Chicago's WTTW-TV for their public auction. Funds received from the week-long auction go into this educational station's operating budget. The set, which had an original manufacturer's suggested retail price of $39.95, was auctioned for $526.00. Offering display assistance here is Barbara Berman, auction volunteer. Goodwin has more than 200 radios in his collection — all Zenith's. His collection spans the history of radio beginning in the 1920's.

Courtesy Zenith Radio Corporation

Dale Goodwin, of Aurora, Colorado, displays just a few of some 200 antique Zenith radios in his collection. Recently he donated a 1939 table model, valued that year at $39.95, to auction on Chicago's educational TV station, WTTW. The set returned a top bid of $526.00. Goodwin has brought his radio display to several department stores in the Denver area in recent years.

J. E. Brown awarded citation

J. E. Brown, retired senior vice president of engineering and research of Zenith Radio Corporation, was recently awarded the special Citation of Broadcast Pioneers for his pioneering efforts in radio and television engineering developments.

The presentation was made at the 31st annual banquet of Broadcast pioneers by Leonard J. Patricelli, president, at the Conrad Hilton Hotel.

The citation honored Brown as, "A man of unusual leadership in engineering . . . an innovator . . . and a pioneer in advanced development programs in color television . . . VHF and UHF broadcasting, FM radio, stereo FM broadcasting and reception, subscription television and other related areas.

"Under his direction, Zenith Radio Corporation's engineering division in 1939 constructed and operated one of the earliest experimental television broadcast stations, W9XZV, which supplied the only available television signal in the Chicago area at the time, permitting the testing of early receivers."

The citation further states that, "Brown was also a leader in the cooperative industry effort which, pooling equipment, research facilities and talents, developed the multiplex system for color TV. This system was ultimately adopted by the National Television Standards Committee, approved by the Federal Communications Commission in 1953, and is used as the standard by color television broadcasters operating today."

Brown, who was born in Greenport, New York on September 11, 1902, was the son of Willis H. and Lottie B. Brown. He attended Cornell University, Ithaca, New York. He married Eudora S. Smith in Geneseo, New York on June 21, 1925. From 1924 through 1936, he was a member of the radio division of the U. S. Department of Commerce, the Federal Radio Commission, and the Federal Communications Commission.

Brown's retirement from Zenith, effective January 1972, came after a 34-year career which spanned the development of TV from its early experimental days. He will, however, continue as a scientific and technical consultant for the company.

Photo Courtesy Zenith Radio

Broadcasting pioneer J. E. Brown, retired vice president-engineering at Zenith Radio, is shown with his 1934 version of the modern TV tube.

Zenith to salute TV's 25th Anniversary

A 90-minute TV spectacular, "Zenith Presents A Salute To Television's 25th Anniversary," will kick off the fall TV season and salute 25 years of television, featuring the superstars of Hollywood.

The special begins at 9:30 P.M. (EDT), Sunday, September 10 on the ABC-TV network. Viewers will relive those early years of "Your Hit Parade," the detective series, kinescopes of early variety programs and sketches of cowboy westerns through comedy, dance and music. Jackie Cooper has specially edited a 35-minute segment of nostalgic and often hilarious kinescope, film and tape segments from the old days. Stars who have offered significant contributions to the TV industry will receive 25-year silver medallion plaques on behalf of the Academy of Television Arts and Sciences.

Here's one of the biggest lineups of Hollywood talent ever to come together on the TV screen during a 90-minute special: Judith Anderson, Jim Arness, Lucille Ball, Milton Berle, Sid Caesar, Perry Como, Jimmy Durante, Dave Garroway, Lorne Greene, Florence Henderson, Bob Hope, George C. Scott, Rod Serling, Dinah Shore, Ed Sullivan, John Wayne, Your Hit Parade cast (Russell Arms, Snooky Lanson, Giselle MacKenzie and Eileen Wilson), and Efrem Zimbalist, Jr. These stars represent 25 years of widely varied programs.

Olde-Tyme Buys

MARKETPLACE FOR COLLECTORS

GENERAL INFORMATION

First word set in all caps at no extra charge. All ads accepted for this section must pertain to old-time parts or equipment, books, periodicals, etc., of historical interest. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their ads must supply publisher with permanent address and telephone number before ad can be run. Closing date: 15th of month preceding month of issue (cover date). For example, September/October issue closes August 15. Remittance must accompany order except ads placed by accredited advertising agencies. Classified ads and correspondence pertaining to same should be addressed to Electronics Digest, Advertising Department, P. O. Box 9108, Fort Worth, TX 76107.

NON-DISPLAY CLASSIFIED RATE

Per line $1.90 (seven words). Minimum order $5.00. Payment must accompany order unless placed by an accredited advertising agency.

IN REMEMBRANCE

By William M. Palmer

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

CHARLES P. STEINMETZ
April 9, 1865 • October 26, 1923

There was a traditional aura of excitement attending the birth of a son – the first born for the young parents. There had been the typical plans and dreams that parents weave for the important childhood years ahead. But one glance at the newborn baby told them that he was hopelessly different – the agonizing realization that cannot be imagined by anyone who has not passed through this traumatic experience. His frail body was misshapen by a humped back, a left leg shorter than the right, and a head that was much too large for the rest of his body. And, although they did not know it at the time, he was going to be a dwarfish four feet three inches in height. The irreversible forces of nature had given their infant an unequal beginning in life. Yet, he was destined to become a genius in the world of mathematics and electrical engineering.

Steinmetz, who was born in Breslau, Germany (now Wroclaw, Poland) on April 9, 1865, was given the name of Karl August Rudolph by his parents, Karl Heinrich and Caroline (Neubert) Steinmetz. His mother died a year later.

In spite of psychological and physical hindrances, Steinmetz developed a zest for study. Perhaps he saw in academic knowledge an opportunity to gain the respect and admiration of his classmates – a kind of psychological compensation for his lack of physical ability to participate in sports and other activities. Intense devotion to study gained the results he desired . . . graduation from the gymnasium (the German high school) at the head of his class.

After entering the University of Breslau in 1883, Steinmetz's insatiable thirst for knowledge prompted him to expand the scope of his studies to include theoretical physics, chemistry, electrical engineering, economics, and special work in advanced mathematics and medicine. His other interests at that time included reading of the classics and journalism.

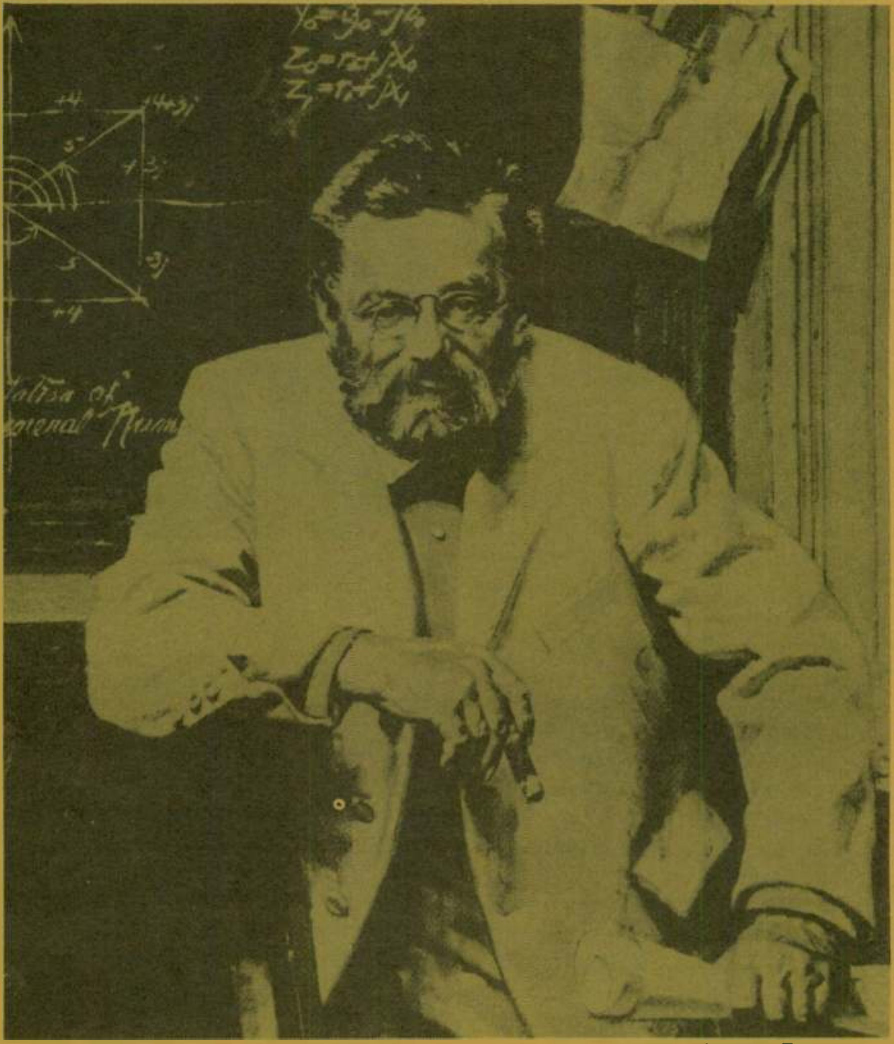
It was during his years at Breslau that one of the members of the mathematics club, of which he was a member, tagged him with the nickname *Proteus*, a name he combined with Charles (the American equivalent of Karl) some years later in an application for United States citizenship.

Notable accomplishments of Steinmetz included his discovery of the law of hysteresis (loss of efficiency in electrical apparatus due to alternating current magnetism) derived mathematically from existing data.

He is credited with having been granted more than 200 patents relating to the broad field of electricity during his long career.

Although Steinmetz never married, he legally adopted as his son and heir a young engineer whose name was Joseph Leroy Hayden. In 1903 his adopted son was married to Corinne Rost, and, shortly thereafter, Steinmetz persuaded the young couple to live with him in his spacious Elizabethan home which he had ordered to be built at about the same time – an unlikely coincidence, since he yearned for family surroundings in his later years.

It was at home, with his adopted family, that Charles Proteus Steinmetz died peacefully the morning of October 26, 1923 – the final chapter in a lifetime of scientific accomplishment for the benefit of mankind. His name will echo through the marbled halls of history so long as man can remember, and his life will serve as a lasting inspiration to those who struggle against the inequalities of nature to reach a place in the sun of achievement – a worthy contribution toward a nobler way of life.

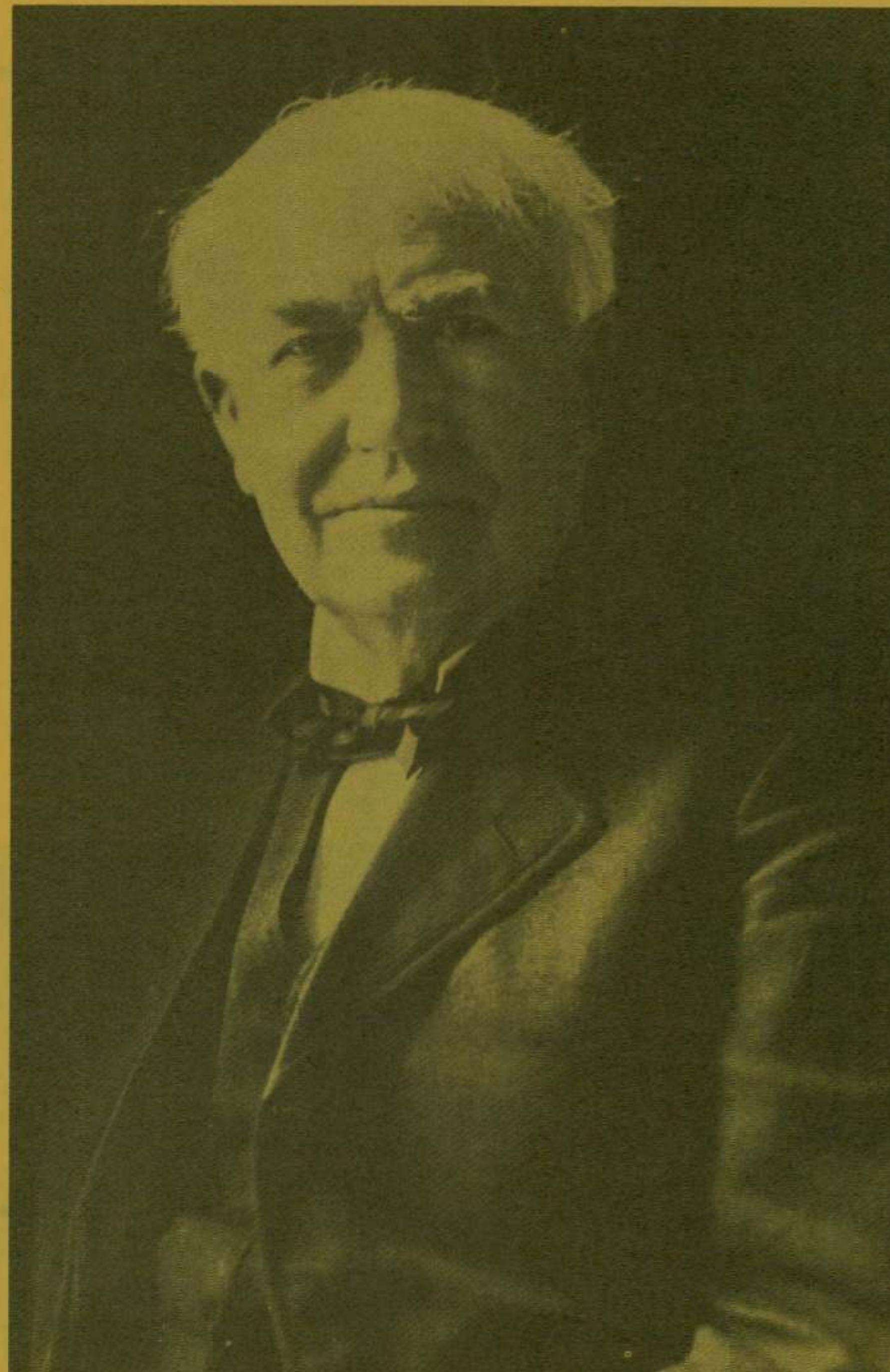


General Electric Co.

Charles Proteus Steinmetz

Reprinted from ELECTRONICS DIGEST for March/April 1970

IN REMEMBRANCE . . .
(Continued)



Courtesy General Electric Co.

Edison granted franchises all over the world to establish new electric power and other industries. He brought men from other countries to the U. S. and trained them to operate these industries. Thus, he exported valuable American "know-how" to enable other countries to enjoy the benefits of electricity.

THOMAS ALVA EDISON

February 11, 1847 • October 18, 1931

There's a brick cottage in Milan, Ohio, modest in size and simple in design, that was the birthplace of one of the greatest inventors of all time – a constant reminder that in America a humble beginning may not hamper the rise to success, nor may it dim the vision of an inventive mind.

Edison, the son of Samuel and Nancy Elliott Edison, was born on February 11, 1847. His mother, a former school-teacher, was the daughter of a Baptist minister in Vienna, Ontario, Canada. Her grandfather, Ebenezer Elliott, had served as a captain in the army of General George Washington.

When young Edison reached school age he had a keen and inquisitive mind, yet he did not do well in classroom study. So his mother withdrew him from school and tutored him until age twelve when he took a job as a newsboy on the train of the Grand Trunk Railroad. His mother taught him to read well, and it instilled a love for books that continued the rest of his life.

The inventor's personal library of more than 10,000 volumes is preserved at the Edison Laboratory National Monument, West Orange, New Jersey, and is administered by the National Park Service.

At age 29, after several successful inventions including the Universal stock ticker for which he received $40,000, Edison the inventor went to Menlo Park, New Jersey, a small village in those days. There he immediately began construction of a laboratory and a home for his wife and their two small daughters.

It was at Menlo Park that the inventor was to make perhaps his greatest invention of all – the incandescent electric lamp. And it was there he earned the affectionate title "Wizard of Menlo Park."

Toward the end of October, 1879, while conducting experiments on the incandescent lamp, Edison placed a tiny carbonized thread, shaped somewhat like a horseshoe, inside one of his sealed glass bulbs. Then the crude lamp was connected to an electric circuit. It responded instantly . . . glowing with a soft light.

More than 1,000 patents were granted to Edison during his lifetime. In addition to the "electric light" bulb, he invented the motion picture, the phonograph, the universal electric motor, the fluorescent lamp, the medical fluoroscope, and many other notable inventions in the field of electricity.

A recipient of worldwide acclaim, Edison died on October 18, 1931, at his home "Glenmont" in Llewellyn Park, West Orange, New Jersey, at the age of eighty-four.

Turney Triple-Spider-Web Inductance Tuner

An interesting replica project of the famous Turney Tuner which was popular in the early 1920s. Build one for your home or school museum.

By Arthur Trauffer

This article describes how to make a near replica of the famous "Turney Tuner" which was popular in the early 1920s. Build one for your home or school museum, and have fun using it in a crystal radio or one tube radio!

As shown in the illustrations, the Turney Tuner consists of a three spider-web coil assembly in a wood box. Stationary coil (L2) is mounted in the frame of the box, while the two adjustable coils (L1, L3) are mounted on swinging "doors" which form the sides of the box. With this arrangement many circuits can be tried out.

The Turney Tuner was a product of the Eugene T. Turney Laboratories, Inc., Radio Hill, Holmes, N. Y. The following bit of history is quoted from a Turney advertisement in the February 1921 issue of Hugo Gernsback's RADIO NEWS magazine:

"Up at the foot of the Berkshires, amid inspiring surroundings, nestles Radio Hill. This ideal radio location is the scene of the development of the Turney Spider-Web Inductance Coils. Here, far from any outside influence, Eugene T. Turney, Radio Engineer, the man who developed the Crystaloi Detector, has brought forth a sensational improvement in machine wound coils."

The ad then describes the virtues of the spider-web coils and the Turney Tuner, as follows:

1. ***More Inductance.*** *There is no magnetic leakage in coupling. The coils are flat, and the entire magnetic area is available.*

2. ***Less Distributed Capacity.*** *The wire runs parallel for a greater distance, and crosses itself less frequently than in any other coil known.*

3. ***Lower High Frequency Resistance.*** *There being no interior magnetic field, or air core, high frequency resistance is reduced to a minimum.*

4. ***Occupies Less Space.*** *The coils are so thin that three of them are less than ¼" in width.*

5. ***More Amplification.*** *Repeater action, caused by tickler flux passing through one coil to excite another.*

THE TURNEY SPIDER-WEB INDUCTANCE

A compact, efficient short wave coil set

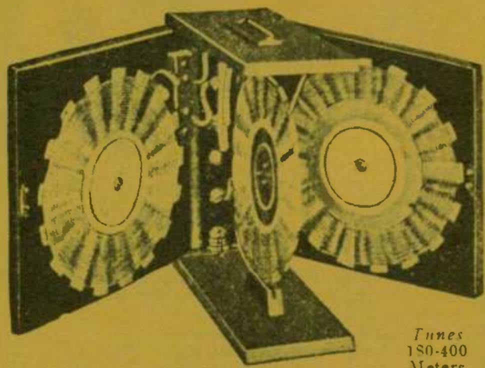


Illustration shows front of cabinet removed.
Patent Pending
Dimensions, 4½ x 5 x 1¾

Tunes 180-400 Meters

WHAT WE CLAIM—

1 Practically no magnetic leakage, which means more mutual inductance and stronger signals.

2 Less distributed capacity than any form of lattice winding which means finer tuning.

3 Occupies much less space than any other form of winding.

PRICE NOW $8.00

The Best $8.00 Worth of Radio You Ever Saw.

PACIFIC COAST AGENTS
HERROLD LABORATORIES
SAN JOSE CALIF.

Ask Your Dealer to Show You ONE or Send Us $8.00 plus Postage and We Will Ship Same Day Order is Received.

Eugene T. Turney Laboratories, Inc., RADIO HILL, HOLMES, NEW YORK

Fig. 1 – Here we turn back the pages of time to the early 1920s in this print from an old advertisement of the Turney Laboratories promoting their famous "Spider-Web Inductance." It had its place as a stepping stone in the gradual evolution of radio to its highly complex development of today.

The original Turney Tuner was designed to cover a band of 175 to 400 meters, but our replica is designed to cover the standard broadcast band of today.

Another old ad, shown in Fig. 1, gives a sales pitch for an original Turney Tuner. Somewhat similar units were manufactured by others.

CONSTRUCTION DETAILS

Fig. 2 is an actual-size pattern for making your own spider-web coil forms. Cut it out carefully and trace it on your insulating material, or you can leave this illustration in the magazine and use carbon paper between the illustration and your insulating material. The writer used Bakelite 1/32" thick, obtained at an electric motor repair shop. Other choices are Formica, or gray sheet fiber, etc. If you must use cardboard for the coil forms, give it two coats of shellac to moisture-proof it.

Fig. 3 shows one of the simple spider-web coils, wound with about 45 turns of No. 26 enameled copper magnet wire. Start the winding on the inside, and zigzag the wire between the spokes, finishing near the ends of the spokes. The ends of the winding are locked in small holes punched or drilled in the form, and glued with Duco cement. Leave enough free wire to connect to your binding posts on the swinging door, as shown. The typewritten (or hand printed) paper disc cemented in the center of the coil form, helps give it the original manufactured look. All three coils should be wound in the same

(Continued on next page)

TURNEY TUNER

(continued from preceding page)

direction, and can have the same number of turns of wire, although a smaller number of turns are sometimes used for the antenna coil (L1) and the tickler coil (L3). You can experiment for best results.

Figures 4 and 5 show the simple construction of the wood frame with the two swinging "doors." The writer used oak exactly ¼" thick for all six pieces. All pieces should be sanded and stained before putting them together. The four pieces making the frame were put together using short nails and Sears Hide Glue, and the two side panels (doors) were mounted using small brass hinges, as shown in Figure 5.

The six binding posts (two for each coil) were made from 8-32 x 3/4" rh brass machine screws, washers, hexagon nuts, and ornamental thumb-nuts, and mounted on the back of the frame and the doors, as shown.

Coils (L1, L3) are screw-fastened to the swinging doors, as shown in Figures 3 and 4. The stationary coil (L2) is mounted in the wood frame using two strips of soft rubber, as shown in Figure 4. For the rubber, the writer used soft pencil eraser, with grooves cut lengthwise in the rubber for the edges of the coil form to set in. This arrangement allows the coil to be removed easily without removing the front of the wood frame.

A small carrying handle was mounted on the top of the box, as shown. This handle can be home-made, or purchased ready-made at hardware or crafts supplies stores. Green felt was stuck to the bottom of the box.

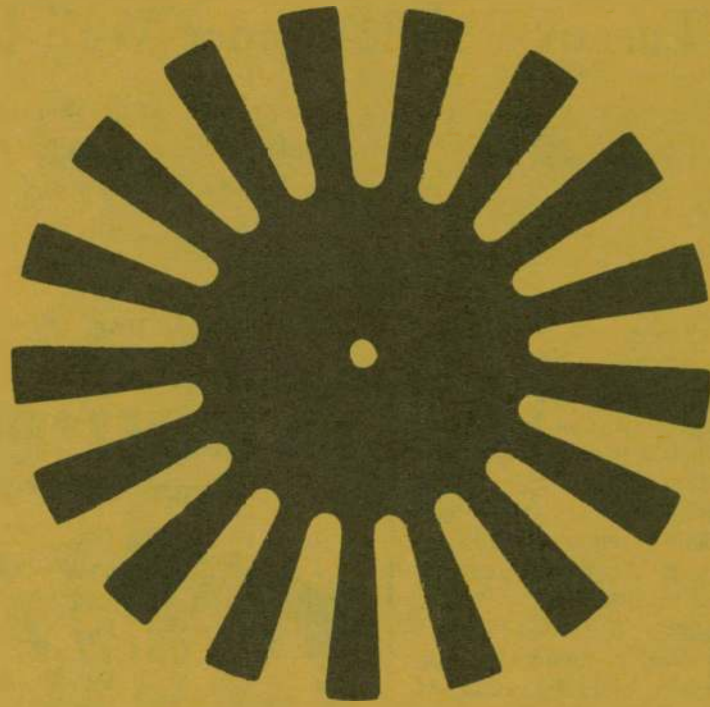


Fig. 2 – This is an actual size contact print made from a Bakelite-Celoron spider-web coil form which was manufactured by the Nazeley Company, New York City, in the early 1920s. Use this pattern for making your own spider-web coil forms.

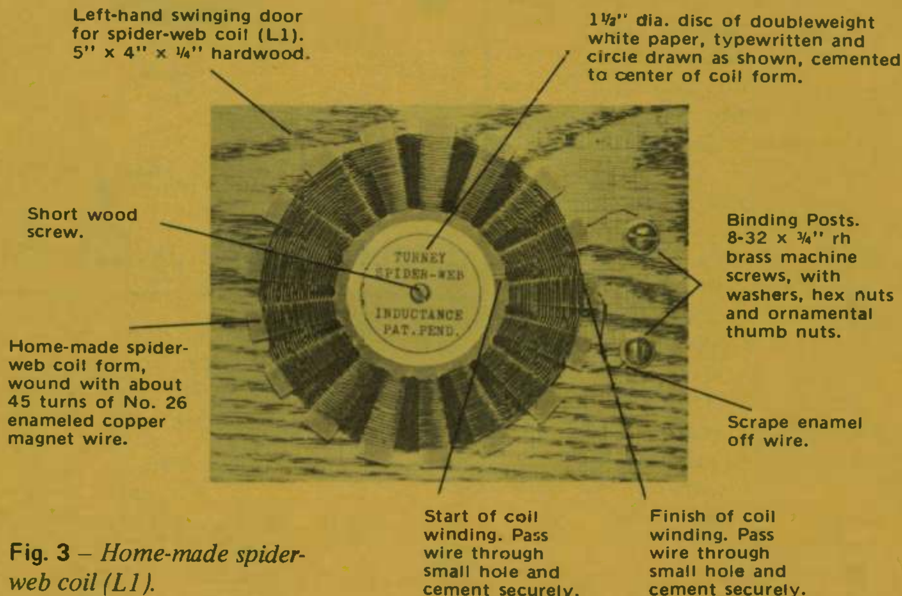


Fig. 3 – *Home-made spider-web coil (L1).*

Two Hook-Ups for the Turney Tuner

Figure 7 is the schematic diagram for a simple crystal receiver using coils L1 and L2 of the Turney Tuner. Swing tickler coil (L3) out of the way, as it is not used. However, you can experiment with all kinds of crystal circuits, using all three coils, and more than one variable condenser! Use a good outdoor antenna, a cold waterpipe ground, and a sensitive pair of high-impedance magnetic (or crystal) earphones, for best results. You can use a galena and cat-whisker crystal detector (see past issues of ELECTRONICS DIGEST) or use a modern germanium diode.

Figure 8 is a schematic for a simple one-tube regenerative receiver, using all three coils. L1 is the adjustable antenna coil, and L3 is the adjustable tickler (or feedback) coil. Use any low filament voltage, low filament drain, or triode battery-operated tube you can find. A "B" battery can be made by soldering enough size "D" flashlight batteries in series to give you 22½ volts (see ELECTRONICS DIGEST, January/February 1970). Again, use a good antenna, ground, and earphones, for best results. With some tubes you may get best results by connecting your grid return lead to "A" plus, instead of "A" minus. If the set doesn't oscillate, try reversing your leads to tickler coil (L3). You can try using a variable condenser (in parallel or series) with the antenna coil (L1). Turning your rheostat to the off position eliminates the need for a filament battery switch.

With all hook-ups, use flexible wire when connecting to your Turney Tuner posts, otherwise your coil doors may not stay where set. The door hinges should not work too freely. ■

This project was suggested by Edward H. Cummings, 65 Colonial Avenue, Cranston, Rhode Island, 02910. Ed is an old-timer (ex-1WP 1913) and once owned and used a Turney Tuner.

TURNEY TUNER *(Continued)*

MATERIALS LIST

1 sheet bakelite or fiber-board, 12" x 4" x 1/32". (For coil forms).
¼ lb. No. 26 enameled copper magnet wire.
2 pieces 5" x 4" x ¼" hardwood (oak, walnut, mahogany). For doors for box.
2 pieces 5" x 1¾" x ¼" hardwood. (For top and base of box).
2 pieces 4" x 1¼" x ¼" hardwood. (For front and back of box).
4 small brass hinges ¾" long and 5/8" wide, with screws. (For swinging doors).
Six brass 8-32 x ¾" rh machine screws.
Six brass hex nuts for above screws.
Six brass washers for above.
Six brass ornamental thumb-nuts for above.
1 small brass carrying handle (For top of box).
Adhesive-back green felt. (For bottom of box).

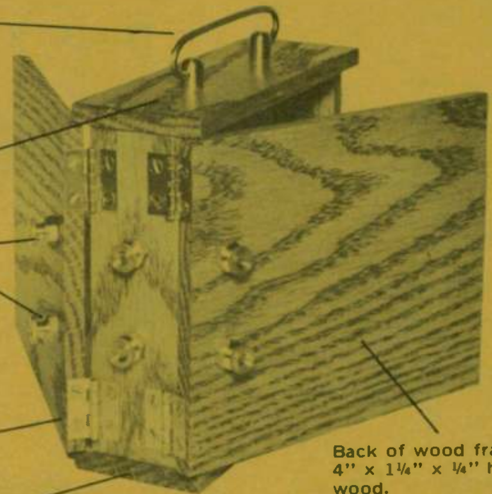


Fig. 5 – Rear View

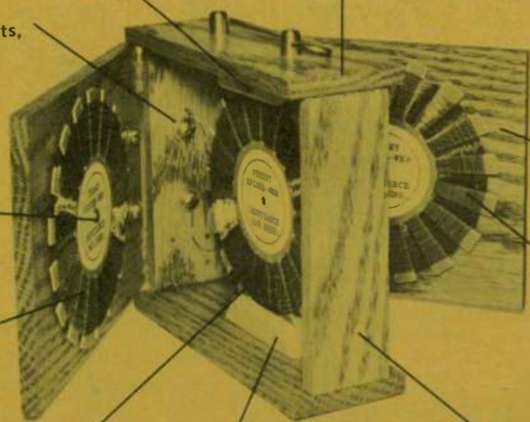


Fig. 4 – Front View

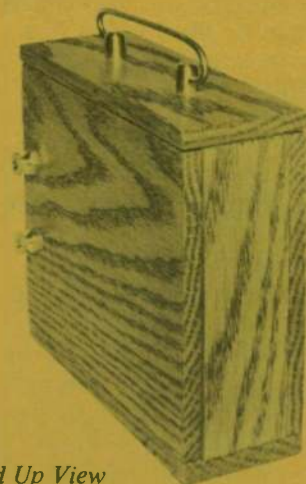


Fig. 6 – Closed Up View

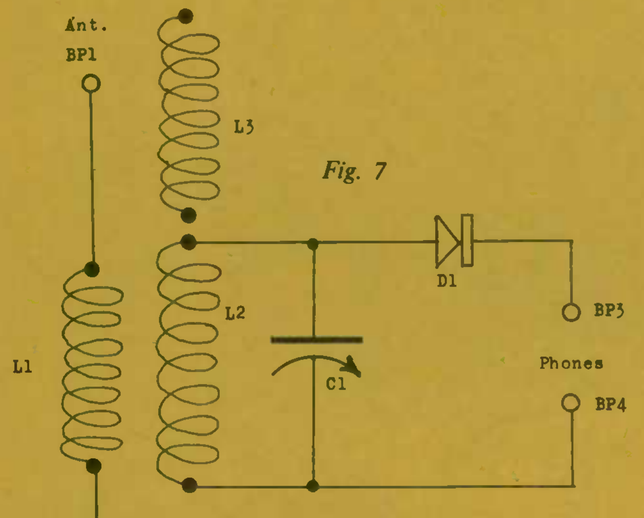


Fig. 7

TURNEY TUNER CRYSTAL RECEIVER

L1 — Primary spider-web coil.
L2 — Secondary spider-web coil.
L3 — "Tickler" spider-web coil (not used).
C1 — Variable capacitor, about 365 pf.
D1 — Crystal detector (diode).
BP1-4 — Binding posts.

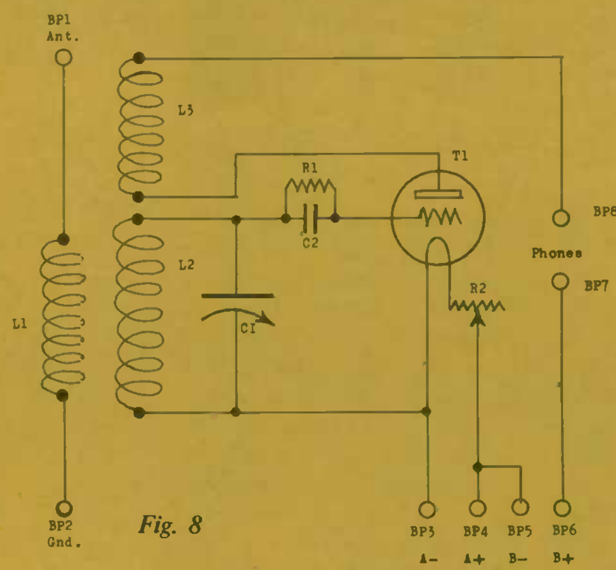


Fig. 8

TURNEY TUNER REGENERATIVE ONE-TUBE RECEIVER

L1 — Primary spider-web coil.
L2 — Secondary spider-web coil.
L3 — "Tickler" spider-web coil.
C1 — Variable capacitor, about 365 pf.
C2 — Grid capacitor, .00025 mfd.
R1 — Grid leak, 2 megohms.
R2 — Filament rheostat (suitable for tube used).
T1 — Any low filament voltage, low drain, triode battery-operated tube.
BP1-8 — Binding posts.

History of the Vacuum Tube

Experimental tubes: commentary on the development of significant phototubes and camera tubes, Tesla and ballast tubes

PART V

by Robert G. Middleton

All types of vacuum tubes go through an experimental or developmental stage before they are finalized. Experimental tubes are generally unbased, and the exhaust tip is exposed. Although Ediswan incandescent lamps were based in 1905, the first Fleming valves were unbased. The final production version of the Fleming valve was provided with a bayonet-type base. Comparatively recent experimental tubes often look similar to commercial Audiotron tubes, which were unbased. For example, one experimental triode appears similar to the DeForest Audiotron (Fig. 1).

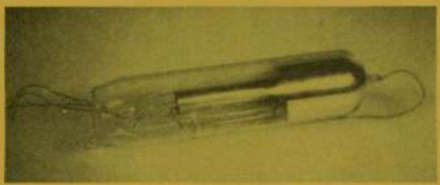


Fig. 1 An experimental triode.

Fig. 2 An experimental Pliotron oscillation detector tube with two anodes, circa 1917.

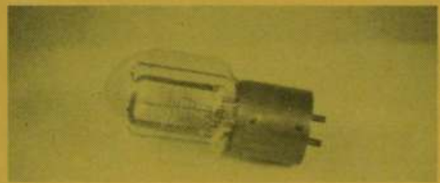


Fig. 4 Shaw-based version of the experimental triode.

Another experimental tube employed a single filament, single grid, and two separate anodes (Figs. 2 and 3). Each of the anodes consisted of a zig-zag section of wire. A later version of this tube was provided with a Shaw base (Fig. 4). In this production design, the two anodes were connected together, and the exhaust tip was placed at the top of the tube, in accordance with 1920 practice. An experimental transmitting tube of the same era was a triode with comparatively large elements for dissipation of appreciable power (Fig. 5).

Phototubes and Camera Tubes

Phototubes were used in the 1930's with scanning-disk television transmitters (Fig. 6). There were various early forms of the phototube (Fig. 7). In 1887, a physicist named Hallwachs observed that a negatively charged zinc plate with a polished surface emits electrons when ultraviolet light strikes the zinc. This is termed the photoelectric effect. A photoelectric tube commonly consists of a glass envelope with an extremely thin film of cesium or similar metal deposited on the inner surface of the glass (Figs. 8 and 9). This constitutes the cathode, which emits electrons when struck by light rays. These electrons are captured by a positively charged anode, which consists of a section of wire.

Some phototubes were opaque except for a "window" opposite the cathode (Fig. 10). Both "hard" and "soft" phototubes were utilized. Those with appreciable residual gas were more sensitive and could be operated at low light levels. However, the highly evacuated phototubes were more stable and had a faster response time. Smaller sized phototubes were used in talking-picture machines (Fig. 11).

In the 1930's, phototubes were progressively displaced by various types of camera tubes. The advantages of a camera tube were in elimination of scanning disks and in the greatly increased quality of picture detail that could be transmitted and reproduced. One of the earliest camera tubes was the first Farnsworth image-dissector camera tube (Fig. 12). The image to be scanned is focused on a photoemissive cathode surface. The anode at the opposite end of the tube has a positive potential, which attracts the emitted electrons. This electronic image is focused by the electromagnetic coils A and

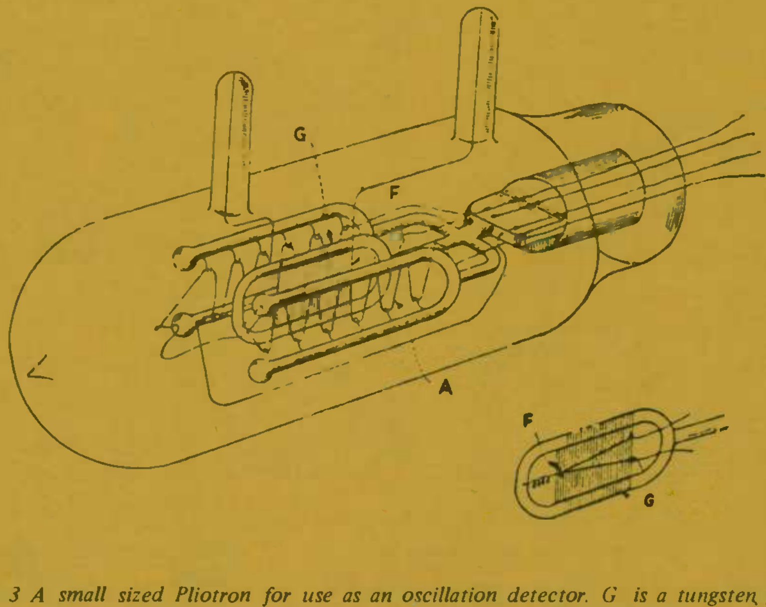


Fig. 3 A small sized Pliotron for use as an oscillation detector. G is a tungsten grid; F, a tungsten filament and A, the anode of tungsten wire. Plan of the experimental detector tube.

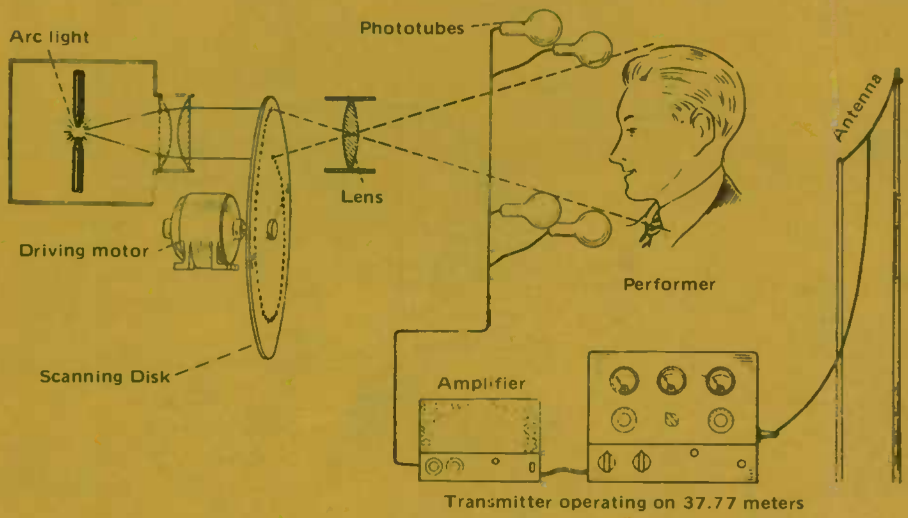


Fig. 6 Plan of a 1930 scanning-disk television transmitter.

Fig. 5 Experimental transmitting triode.

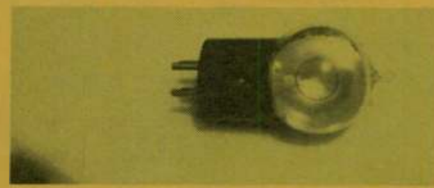


Fig. 7 A phototube used in an early scanning-disk television transmitter.

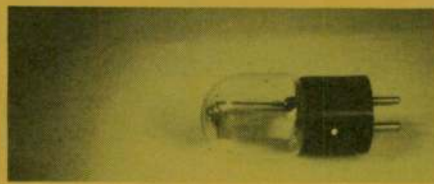


Fig. 9 Another early type of phototube.

Fig. 10 A phototube with a "window" envelope.

Fig. 11 A small phototube, used in talking-picture machines.

A1. Deflection coils B and B1 move the electronic image back-and-forth, so that it is scanned by the anode aperture. Another pair of deflection coils is provided to move the electronic image up and down.

In this same era, another type of camera tube called the iconoscope was being developed by RCA (Figs. 13 and 14). A mosaic electrode is employed, designed for high electron emission. It is formed by deposit of myriads of tiny silver globules on a sheet of mica. These globules are photo-sensitized with cesium, and each globule constitutes a tiny photoelectric cell. An electron gun and beam-deflecting system are mounted in the neck of the iconoscope. Electrons emitted by the globules are attracted to the silver coating inside the tube, which operates as the anode, or collector.

Emitted electrons will leave a charge deficiency on the mosaic, which in effect produces a tiny capacitor charge with respect to the backing plate. The function of the cathode electron beam is to discharge these globules in a scanned order. In turn, the potential between the backing plate and the collector varies in the scanned order, and a video signal appears across resistor R. The chief advantage of this iconoscope design was improved sensitivity, compared with the image-dissector tube.

A later version of the Farnsworth camera tube employs a photo-island grid upon which the image is focused after passing through the transparent anode at the end of the tube (Fig. 15). This grid had approximately 160,000 holes per square inch in a thin nickel plate. One side was coated with a dielectric material upon which were

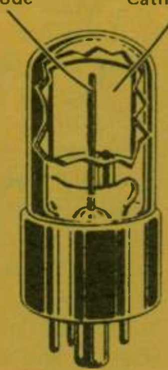


Fig. 8 Construction of a phototube.

deposited many photosensitive "islands." In turn, the image focused upon this photoemissive surface established an electrical potential image. The electron beam from the gun struck the surface of the nickel plate, liberating secondary electrons. These secondary electrons constituted a virtual cathode source, and were drawn through the tiny holes of the mesh. The charge distribution over the mesh produced grid action, and determined the number of electrons that were emitted at a given point to proceed to the electron multiplier. This tube had the advantage of higher sensitivity than the iconoscope.

Next, the Zworykin image iconoscope was developed (Fig. 16). The image to be televised was focused upon the photoelectric cathode near the end of the tube. In turn, an electronic image was emitted from the opposite surface of the cathode. This image was focused by suitable means on the mosaic at the other end of the tube. Secondary electrons from the globules were carried off by the anode coating, and a charge distribution was thus established between the mosaic and the backing plate. Secondary emission represented electron multiplication and an increase in sensitivity.

The image orthicon is a later development of the foregoing camera tube (Figs. 17 and 18). It is a storage type camera tube and has very high sensitivity compared with the iconoscope. Photoemissive response is increased by using a conducting photosensitive sur-

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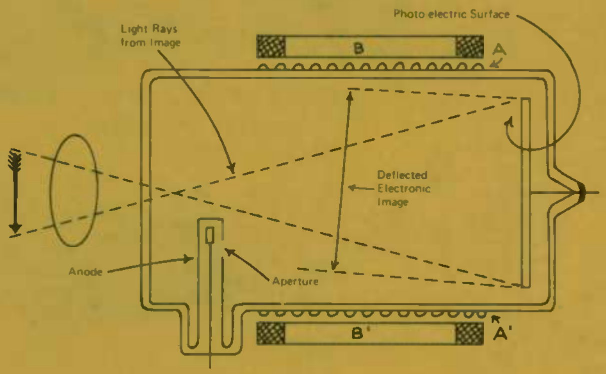

Fig. 12 Plan of the first Farnsworth image-dissector camera tube.

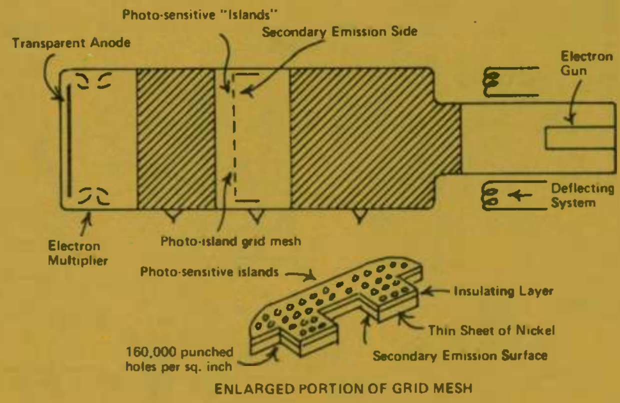

Fig. 15 A later version of the Farnsworth camera tube.

HISTORY OF THE VACUUM TUBE

(Continued from preceding page)

face. Secondary emission, with its undesirable side effects, is eliminated by scanning with a low-velocity electron beam. Finally, the signal-to-noise ratio is improved by utilizing a photomultiplier section. The light rays are focused on one side of the photocathode, and photoemission takes place from the opposite side. Scanning is accomplished on a separate plate called the target electrode. The video signal is produced by the electron beam that returns from the target and which moves toward the cathode from which the electrons were emitted.

A light image is focused on the transparent photocathode. Emitted electrons are accelerated toward the target by grid No. 6. The target is a thin glass disk with a fine mesh screen on the photocathode side. Secondary electrons are emitted, which are collected by the wire mesh. Emitted electrons from the photocathode side of the target set up a positive charge. Next, the rear side of the target is scanned by a low-intensity electron beam. Grid No. 4 is a focus grid, and grid No. 5 slows down the electrons. Some of the beam electrons neutralize the charge on the glass target, and the remainder return to dynode No. 1. This is the first stage of the electron-multiplier section, which provides a gain of approximately 500 times.

Another type of camera tube was called the vidicon (Figs. 19 and 20). It is smaller than an image orthicon, but has good performance. It comprises an electron gun, a grid No. 3 beam-focusing electrode, a grid No. 4 fine-mesh screen, and a target. An electron gun is provided, consisting of a cathode, grid No.

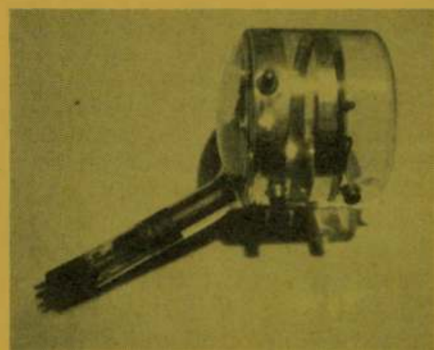

Fig. 13 A Zworykin iconoscope camera tube.

1 control grid, and grid No. 2 accelerating grid. The electron gun provides a low-velocity electron beam which is focused in part by grid No. 3. The target employs a transparent conducting film on the inner surface of the face-plate. A point on the photoconductive layer becomes slightly conductive when exposed to light.

Grid No. 4 sets up a decelerating field. Since the photoconductive layer is positive, it collects electrons when scanned by the beam. However, as the surface potential rises, arriving electrons are turned back. Thus a charge distribution is produced on the scanned surface, and its discharge through an external circuit from target to cathode produces the video signal. Vidicon tubes are widely used in closed-circuit TV cameras (Fig. 21). They also find considerable application in TV station operations.

Because the image-dissector tube produced a very weak output signal in its original form, Farnsworth developed an electron-multiplier tube, which he termed a multipactor. This type of tube is called a photomultiplier today (Figs. 22

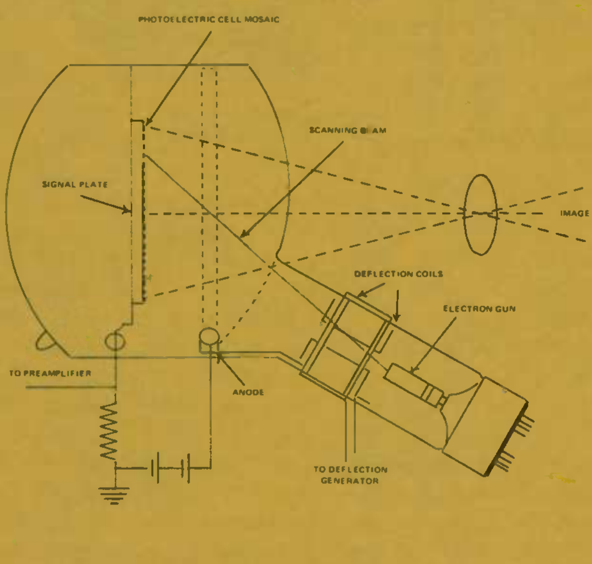

Fig. 14 Plan of an iconoscope.

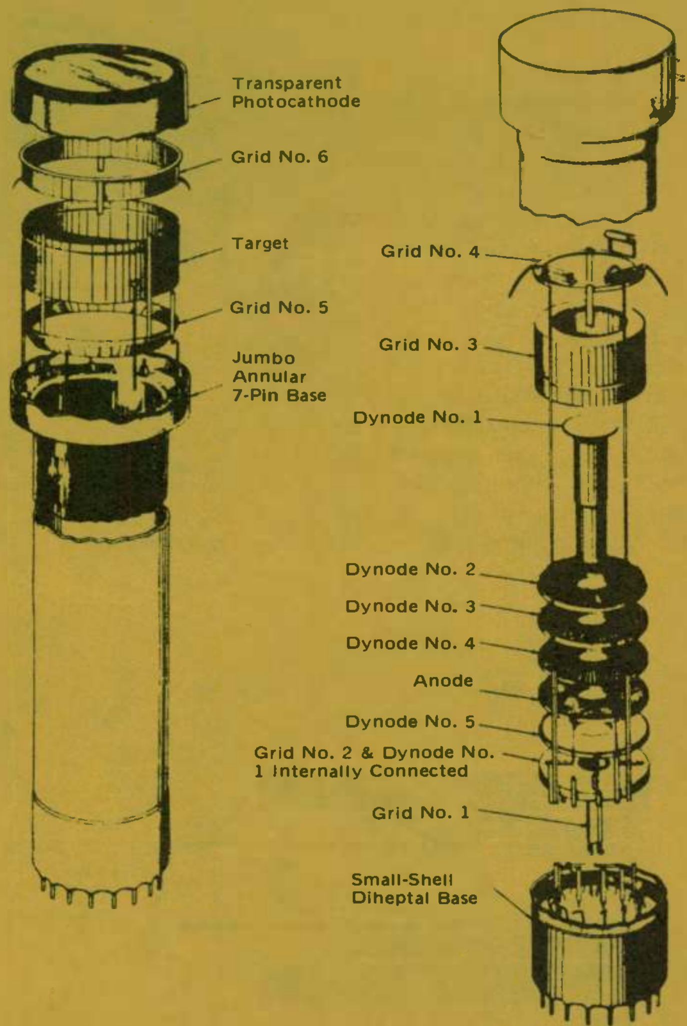

Fig. 18 Construction of an image orthicon tube.

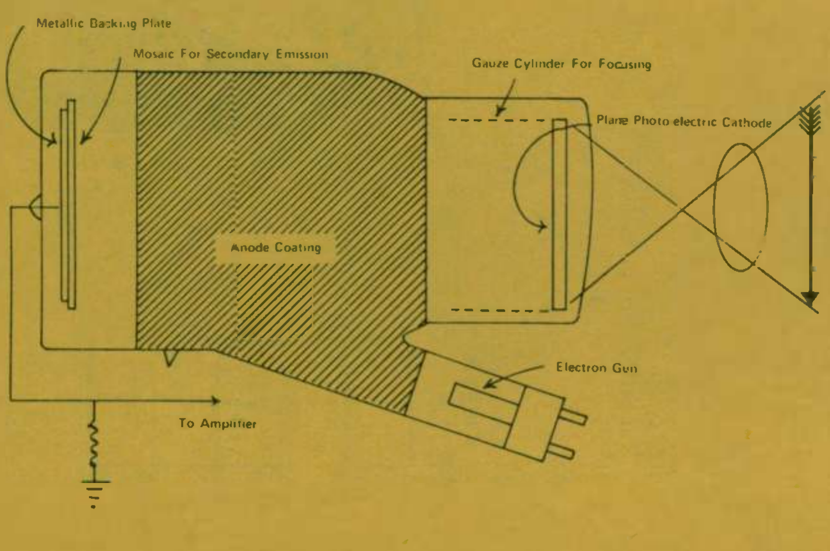

Fig. 16 Plan of the image iconoscope.

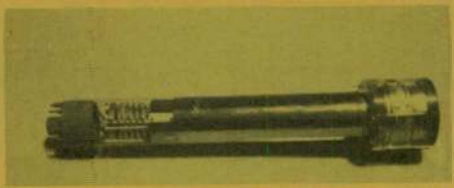

Fig. 17 An image orthicon tube.

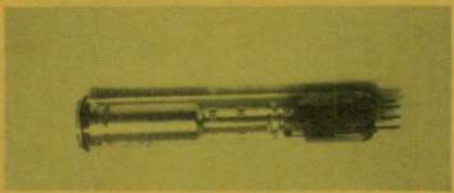

Fig. 19 Appearance of a vidicon camera tube.

and 23). Basically, it is a phototube with electrodes arranged to produce secondary emission and build up weak electron currents. Light that strikes the photocathode causes electron emission. These electrons are attracted to the first dynode, which has a positive potential. Secondary electrons are emitted, and the process continues until final collection by the anode. An amplification of 60,000 times is typical.

Tesla Tubes

Among unusual and ephemeral tubes was the Tesla tube (Fig. 24). This was a gas tube with one electrode. It was energized from a Tesla coil connected between the tube and ground. Corona discharge took place from the electrode inside the tube, due to stray capacitance. In turn the tube glowed (typically a purple color). If the operator brought his finger near the glass envelope of the tube, sufficient capacitive current would flow to produce a small spark discharge. Tesla tubes were made in many forms, and were used chiefly in popular electrotherapeutic devices in the 1920's. These units were called violet-ray machines.

Tesla tubes were also used in ozone generators (Fig. 25). These were elongated tubes, suggestive of Geissler tubes. However, each tube had only one electrode. When energized from a Tesla coil, the tubes glowed. One set of tubes glowed orange, and the other set glowed purple. The ozone was actually produced by corona discharge, and the Tesla tubes merely added a spectacular appearance to the generator. The ozone

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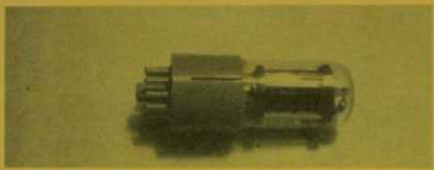

Fig. 22 A modern photomultiplier tube.

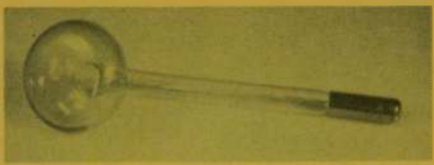

Fig. 24 A Tesla tube.

was employed as an air deodorizer and purifier and was also supposed to benefit respiratory ailments.

Ballast Tubes

The filament current for early vacuum tubes was controlled manually with a rheostat. However, in the later 1920's automatic current control was introduced to simplify the operation of radio receivers. The first device used for current stabilization was the ballast tube, also called a barretter (Figs. 26 and 27). It consisted simply of an iron-wire spiral in an atmosphere of hydrogen. Because of the large temperature coefficient of iron, practical current stabilization resulted. Barretters were also designed which operated in air; however, their response time to a voltage change was slower than for hydrogen barretters.

Photo Courtesy Ampex Corp.

Fig. 21 A closed-circuit TV camera that uses a vidicon tube.

Fig. 26 Example of a barretter, or ballast tube.

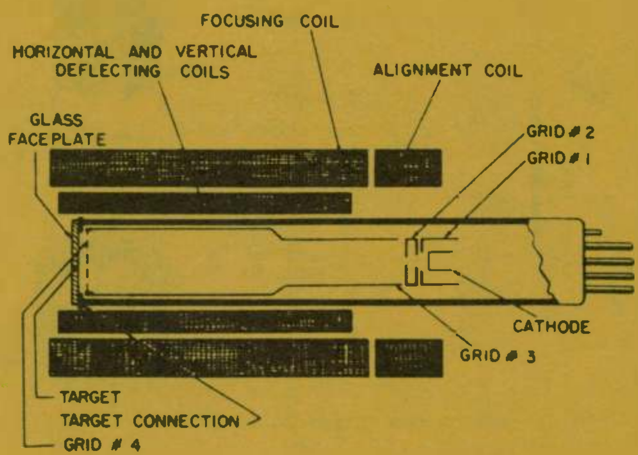

Fig. 20 Construction of a vidicon camera tube.

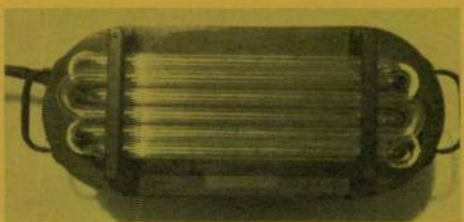

Fig. 25 Tesla tubes in an ozone generator.

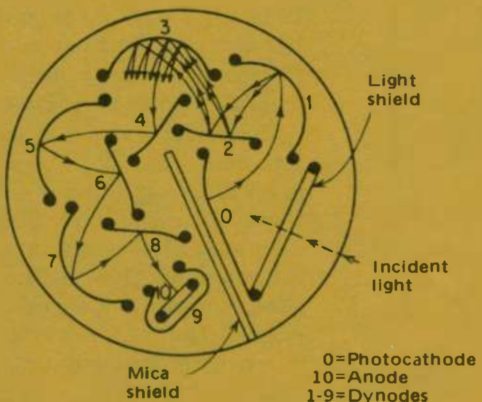

Fig. 23 Plan of a photomultiplier tube.

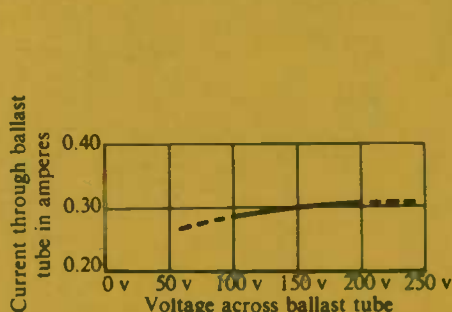

Fig. 27 Typical E-I characteristic for a barretter.

FROM AN ALBUM™

PICTORIAL HISTORY OF ELECTRONICS

Courtesy Zenith Radio

"HELLO AMERICA" were the first words heard in 1924 on this early Zenith radio rig by Hiram Percy Maxim, former president of the American Radio Relay League. He is shown in this photo published in April, 1924 by Popular Science magazine with his 1922 model 1R Zenith tuner, bottom right, and the 2M two stage amplifier, bottom left. Both sets carried the Chicago Radio Laboratory name – the predecessor name to Zenith Radio Corporation.

This history-making picture is the first television broadcast in Chicago on March 30, 1939, which was conducted by Zenith Radio Corporation on an experimental basis. The telecast was received 18 miles from the TV transmitter. Engineers at station W9XZV pictured here include: (from left), WLS Chief Engineer, Tommy Rowe; Howard Black; Reggie Cross; and J. E. Brown, Zenith television engineer. Rusty Gill is kneeling in front.

Courtesy Zenith Radio

In 1956 Zenith introduced this unusual method of remote control tuning – the Flash-Matic system. It operated with a flash of light to turn the set on and off and change channels. It was advertised to "shoot off long, annoying commercials while picture stays on the screen." Earlier, Zenith had introduced its "Lazy Bones" remote control system which changed TV channels in any direction utilizing a hand-held control device connected to the television set by wire. In 1957 Zenith introduced to the industry its Space Command remote control tuning system utilizing high frequency sound.

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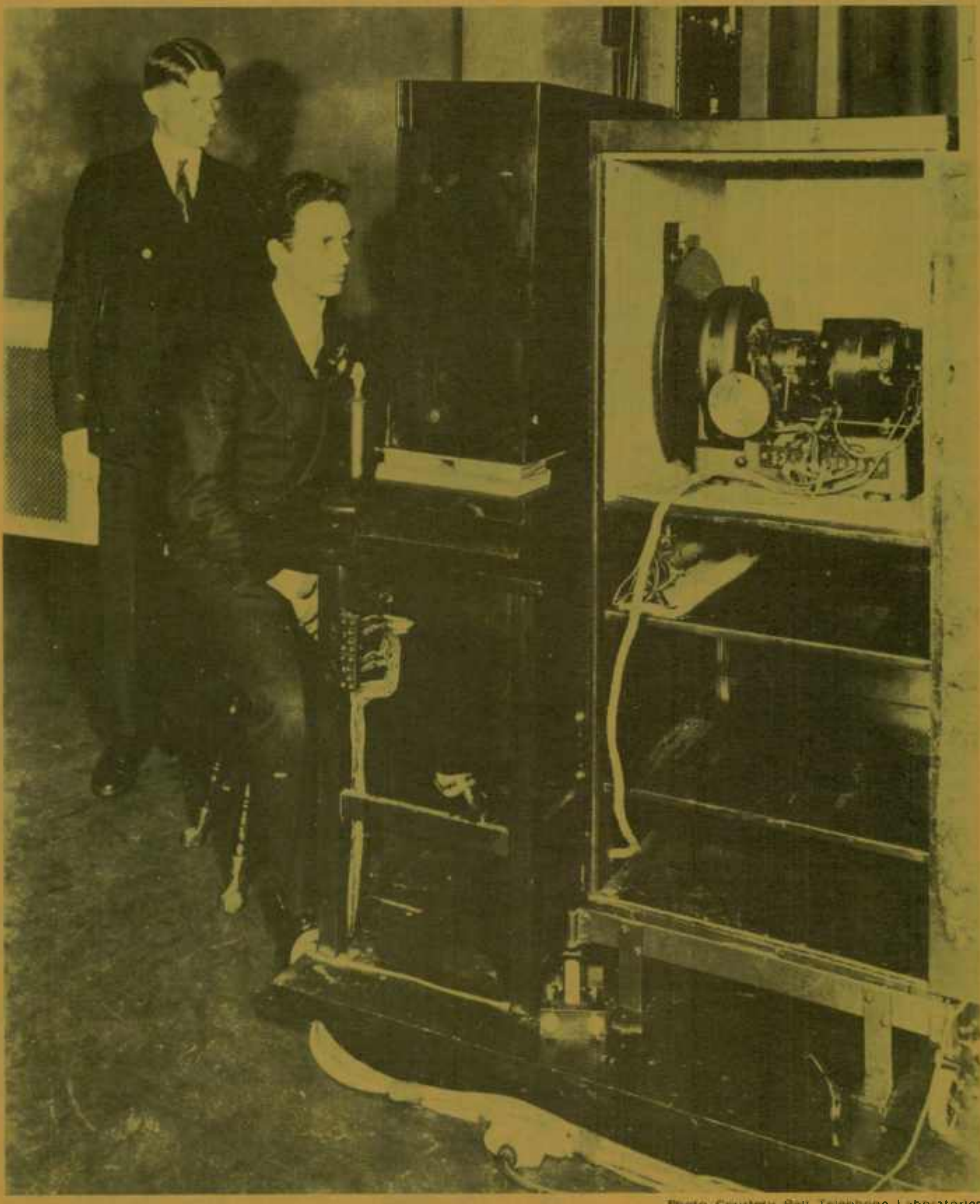


Photo Courtesy Bell Telephone Laboratories

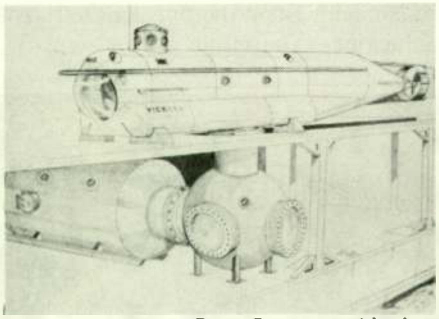
TWO OF TV'S PIONEERS John R. Hefele, seated, and Frank Gray (both retired) were two of an estimated 200 Bell Telephone Laboratories scientists, engineers, and technicians whose work contributed to the success of the first U.S. demonstration of intercity television which took place 45 years ago. Many research problems involving this television transmission and other apparatus were solved under the direction of Dr. Gray.

OCEANOLOGY
(Continued from page 14)
the Marine Board of the National Academy of Engineering emphasizes the necessity for overall, integrated planning and leadership to enable the United States to regain its position as one of the world's foremost maritime nations, and to ensure the "most effective utilization of all the resources of the sea for the betterment of our country and all mankind." The United States has been for many years an important maritime nation; however (the report points out), "our interest in the ocean has not been consistent: we have been both wise and, occasionally, foolish in using the sea." Today the nation faces a challenge not only to exploit more fully the rich resources of the sea, but "to do so with concern for a balance among the many demands now being placed on the marine environment. We face an unprecedented opportunity to explore the seas in greater detail than has been heretofore possible and to utilize the results of this exploration for the advancement of the quality of life on this planet."

Recommendations adopted by the Board for the establishment and operation of a "truly national ocean program" are supplemented by individual panel recommendations concerning specific areas such as commerce and transportation; living and nonliving resources; protection of the environment; exploration and surveying; construction and civil works; vehicles and platforms; navigation; instrumentation; communication; and education and information dissemination. Panel members point out that a critical need for engineering-related exploration and the development of exploration techniques and equipment had been identified in their evaluation. Man's ability to work in the sea should be expanded through projects such as the Navy's Deep Submergence Rescue Vehicle program, the Sea Lab program, and man-in-sea programs. In the opinion of the Marine Board, the nation has begun to move toward an effective national marine program with the establishment of the National Oceanic and Atmospheric Administration and the Environmental Protection Agency, but it must greatly enlarge its use of existing ocean technology: it is especially important, notes the report, that "the factors governing wise application of this technology be understood at all levels of industry, government and private life in this country and internationally, if the present and potential capabilities of the United States and the world are to be effectively mobilized."

Modular "window-nose" sub

Perry Oceanographics, Inc., a pioneer in high-visibility workboat submersibles, has begun construction of a transparent-nosed modular diver lockout submarine with mating deck chamber complex, to be used in the North Sea. The new PC-15 – a four-man, 14-ton submarine, operational to depths of 1,200 feet – is scheduled for completion in early 1973. The sub will be 31 feet long and will cruise at one knot up to 15 hours – maximum speed at five knots. Payload, in addition to passengers, will be 2,000 pounds. Main sections of the PC-15 will be modularized and bolted together. The modular construction feature will lower assembly and maintenance cost and assure against obsolescence as new power and propulsion systems are developed in the future. For special missions, the entire lockout section and gas sphere may be removed and the tail section bolted to the front section, making a smaller three-place observation submarine with 1,000-pound payload capacity.


Perry Oceanographics Inc.

Artist's sketch of the new PC-15 submarine mated to its deck decompression chamber complex.

Batteries for the PC-15 will be in twin exterior pods below the hull, giving good stability and providing natural skids for landing on deck or on the bottom. Pipelines can be straddled, bringing the pipe within inches of the 42-inch-diameter acrylic window. Quick-change trays will enable battery exchange and full turn-around in two hours. A removable conning tower will have six viewports for horizontal viewing, plus an upward-looking viewport in the conning tower hatch. The aft, or diver compartment, will have a downward-looking viewport in the lockout hatch and four viewports for horizontal viewing to each side. The diver lockout feature will enable two divers to be delivered to the bottom at one atmosphere, pressurized to depths of 1,200 feet with the sub's gas storage sphere, and exit from the sub to carry out work. Equipment will include gyro-compass, auto-pilot, underwater telephones, sonar and manipulators.

The British firm of Vickers Oceanics will operate the PC-15 system from their 2,800-ton support ship, "Vickers Voyager," offering submersible services to the burgeoning offshore industry in the North Sea.

Radar measures wave heights

Scientists from the Naval Research Laboratory in Washington have proven ocean waves may be measured from above-the-surface platforms by making minor modifications to the Laboratory's X-band nanosecond-pulse test radar. It had been previously reported that the problem of measuring ocean wave heights from fixed-shore or bottom-mounted sensors had been solved by the use of through-the-surface sensors; however, NRL Radar Division scientists say these sensors have maintenance and reliability problems – the below-the-surface sensors, in particular, have restricted frequency response problems in bad weather. These difficulties, they say, indicate that an above-the-surface sensor, with a frequency response comparable to that of through-the-surface sensors, is definitely needed to report wave-height information up and down the U. S. east coast to the U. S. Army Coastal Engineering Research Institute in Washington and for general use in navy operations. As a result of recent research, headed by G. F. Myers of the Radar Division, such a system has been proven feasible: wave heights have been accurately measured – looking vertically from above the surface – with a precision that equals that obtained when using a through-the-surface wave sensor. Myers said research using the modified NRL test radar system and stable platforms 20 to 60 feet above the surface have given excellent results, and a brief test made with a helicopter flying 100-feet up at 60 to 100 knots forward speed, indicates good future possibilities for use of such a platform in wave-height measurement.

Improved echo signal processor

A new correlation echo sounder processor, the CESP-II, for bathymetric data collection has been introduced by Raytheon Company's Ocean Systems Center,
(Continued on next page)

Portsmouth, Rhode Island. An improved version of the CESP-I – introduced in 1970 – the new signal processing device effectively increases acoustic output energy of standard high resolution depth sounding systems by a factor of one hundred. Its several improvements over the earlier unit include a choice of pulse lengths, smaller physical size, and more extensive use of integrated circuits.

In operation, long, wide-band, outgoing transceiver pulses are stored within the logic of the unit and used as reference replicas for returning echoes. The particular characteristics of transmitted signals are not normally present in interfering noise; consequently, noise does not correlate and does not appear on the graphic recorder output display. For similar reasons, reverberations caused by various sub-bottoms do not correlate, allowing closely spaced layers to be displayed unobscured. At higher frequencies, the CESP-II insures that signals are clear enough to be automatically processed or digitized. At lower frequencies it increases penetration into the near sub-bottom. Since the equipment provides high signal-to-noise ratio and increased noise immunity, it is particularly suited to ships having noisy propulsion systems.

COMMUNICATIONS

New Navy sub VLF system

During the past few years, Naval Research Laboratory scientists have been intensively studying electromagnetic wave propagation at very-low-frequency (VLF) between a newly-constructed transmitter at North West Cape, Australia, and receiving sites located in Japan, Madagascar, Bahrain Island, Alaska and the Philippines. The North West Cape VLF transmitter broadcast signals on a schedule which permitted propagation data to be collected at the receiver sites on six frequencies in the VLF band over a three-month period. The research effort, sponsored by the Naval Electronics Systems Command, has been directed toward obtaining information on VLF propagation paths that had not been previously investigated, to determine which frequencies are most suitable for communication transmissions to Navy submarines. The results of the research promise an important advance in Navy submarine communications and possibly a spinoff benefit for both commercial and Navy ships using the Omega navigational system.

Data collected from the experiments were compared with theoretical predictions. Some effects of multimode propagation were found to be evident in data taken during the nighttime period; moreover, the nighttime signals were more variable than daytime signals, which appeared to be influenced by the direction that the propagation path made with the earth's magnetic field. As a result of the investigations, the Naval Research Laboratory has now been able to give the Navy infromation on the most suitable VLF channels to use for transmissions to submarines from an existing site.

Microwave network links TV

A new microwave communications network interconnecting television stations in Seattle, Yakima and Spokane, Washington, and Portland, Oregon, recently began service. Designed and built by Raytheon Data Systems of Norwood, Mass., the high reliability system includes equipment located at nine television stations in the four cities and at 13 locations along the routes. In addition to bringing network television programs originating elsewhere into the nine stations, provision is made to send out nationwide — via reverse channels in the microwave network — programs originating in Washington, such as spot news and athletic events. Audio and video signals for the three major television networks are beamed from mountain-top to mountain-top in average hops of 39 miles each to cover the 436 route miles. There are more than 100 separate transmitter and receiver units along the route, each about the size of a telephone booth; these employ Raytheon's KTR-2A and KTR-3A transmitter receivers.

To insure program continuity for the nine TV stations and their viewers, each of the Washington stations is equipped with three receive channels. The principal channel is that station's network channel. The other two are for occasional use and for standby protection to guard against program interruption. A minicomputer serves as the electronic watchman and trouble-shooter for the system. This data logger senses up to 128 points at each station. Each electrical check point is stored in the computer's memory. When a trend away from peak performance, or a failure, is noted, an alarm is sounded and engineers can correct the problem before it causes a serious interruption in the television signal. The minicomputer not only helps maintenance engineers anticipate trouble, it also helps direct their attention to the trouble spot, thereby reducing maintenance time. The watchdog system also serves as an intrusion alarm: should someone climb a mountain top to tamper with the signal — or any of a score of similar occurrences, engineers are warned of this immediately.

The system — controlled from Portland, Oregon, at the Television Operating Center — is an addition to the more than 13,000 route miles of microwave links operated by Tele-Communications, Inc., of Denver.

Bell's no. 4 ESS switching system

Photo Courtesy Bell Labs

Paul Wiley, member of Bell Labs Technical Staff, removes circuit pack in No. 4 ESS switching system scheduled for service by the end of 1975.

Bell Labs is developing a new electronic switching system for the Bell System that will handle about 350,000 long-distance calls an hour — three times as many as the electromechanical toll system now being used. The first installation of the system, known as No. 4 ESS, is slated to begin service in Chicago by early 1976. No. 4 ESS will replace electromechanical parts with solid-state components to switch digital signals directly — for the first time in the Bell System. The new system will be capable of switching the digital bit stream from transmission lines used in T1 and T2 carrier systems. Switching digital signals directly reduces the need for conversion of such signals to analog form. In addition, No. 4 ESS is expected to take up less floor space, primarily due to the use of small, reliable, integrated circuits which contain many electronic components on a tiny silicon chip.

SPACE RESEARCH

Long-duration spaceflight

A recent report, prepared for NASA by the Space Science Board of the National Academy of Sciences – National Research Council, stresses that in planning for long-duration spaceflight, the spacecraft will have to be viewed as a "microsociety in a miniworld," with more concern for the social needs of individual crew members; attention will have to be turned from the spacecraft itself – which has logically absorbed all attention in the first decade of space research – to the special human requirements of the men who will live in it for periods of up to two years at space stations and laboratories. Despite the success of the manned space program to date, the report states that scientists cannot ensure that man will be able to tolerate longer flights: a great deal more must be known about a whole range of physiological and psychological factors – from deconditioning of body systems during long flight, to possible impairment of mental performance due to lengthy isolation and confinement. Research is critically needed to determine the effects of confinement, isolation and sensory deprivation on cognitive functioning; retention of skills and mental alertness; sleep and work-rest cycles; and on interaction among crew members. "While questions regarding the long-term physiological effects of weightlessness remain unanswered," the report states, "consideration must also be given to the maintenance of health over extended periods of time without access to elaborate medical facilities, to provision for adequate training to handle extremely complex tasks, and to crew selection that takes into account ability to tolerate long-term isolation from the outside world except for communication with ground control."

The report recommends that first priority in research be given to determining the course of physical deconditioning over a two-year period. Weightlessness and restricted activity in the spacecraft can lead to general deconditioning and specifically to deconditioning of the cardiovascular, musculoskeletal, metabolic and neuroendocrine systems. There was evidence of deconditioning with no ill effects during the longer Gemini and Apollo missions, but little is known about whether deconditioning would progress with length of stay in space, or whether the human body would adapt. More study is also needed on another potential hazard in deep space – high-energy heavy cosmic rays, known as high-Z particles. Radiation from these particles may adversely affect nondividing cells in the central nervous sytem.

In view of the changing demands of long-duration flight, the report further recommends that the space "mission" be redefined to include the entire period from designation of the crew through postflight debriefing and flight reports. The report advocates the inclusion of the flight crew in mission tasks from the very beginning of preparation: "individuals selected for the astronaut program must be integrated into the total effort in such a way that they are willing to make a single flight the culmination of a career."

New hi-temp strain gage

A new high-temperature capacitance strain gage that can measure structural stresses imposed at temperatures as high as 2000 degrees Fahrenheit has been developed – in a five-year program – by Hughes Aircraft Company for use in the development and qualification testing of aircraft, missiles and space vehicles during simulation of external loads and temperatures in the flight environment. The ½-inch-long gage is a rhombic frame with a capacitor element composed of Iconel plates and mica dielectric insulators. The sensor is incorporated in a TD nickel chrome frame with mica insulators to transmit stresses in the base material as it is strained under aerodynamic or temperature loads into changes in capacitance due to alterations in the distance between the steel plates; these capacitance changes are the measure of strain being endured by any test vehicle.

More than 20 configurations were studied for attachment of the strain sensor to various structural materials. Three techniques for attachment to the test vehicle were investigated: welding, flame spraying and bonding. Flame spraying was considered the best means for the strongest attachment at 2000 degrees Fahrenheit, although welding was preferred because it was the easiest to perform.

Temperatures associated with present-day aircraft, space and missile vehicles are in the 1000 to 1500-degree range but this region is expected to increase to 3500 to 4000 degrees during the late 1970's; laboratory tests have demonstrated that the new gage provides a positive and accurate means of measuring structural stress at temperatures up to 1750 degrees Fahrenheit, and under specific test conditions data can be obtained as high as 2000 degrees.

More than 100 gages have been bought by the Department of Defense and NASA for test purposes in such programs as the space shuttle and additional quantities have been purchased by several firms engaged in aircraft and missile programs.

Logistics support for NASA

Raytheon Service Company of Burlington, Massachusetts, was recently selected by the National Aeronautics and Space Administration for $42.5 million contract negotiations – over a three-year period – to provide continuous logistics support for tracking, data acquisition and communications facilities for the NASA Space Flight Space Tracking Data Network (STDN), managed by the Goddard Space Flight Center. Under the provisions of the contract, Raytheon will provide logistic support services to the Goddard Space Flight Center project control centers; communications switching centers; and network tracking stations, training centers, test facilities, instrumented aircraft and calibration and repair facilities. Services will consist of all material, personnel, utilities, automatic data processing, system modification and program modification required to manage and operate a depot near Baltimore, Maryland, in support of the equipment and facilities of a world-wide network.

ECOLOGY

NY/NJ Atlantic dump site study

The New York City dump site off Sandy Hook, N. J., was one of the places visited by deep-diving submersibles operating in the Atlantic Ocean in recent summer months in a program under the direction of the Manned Undersea Science & Technology Office of the National Oceanic and Atmospheric Administration. The intensive undersea study, which began June 19, involves the movement of sediments along the seafloor in an area called the New York Bight. Westinghouse Electric's *Deepstar* 2000 submersible and the Navy's submersible, *Alvin*, operated by Woods Hole Oceanographic Institution, were used for on-site examination of the seafloor. The surface ships *Lulu, State Wave* and *Venture* supported the submersibles while making seismic profiles and side-scan sonar recordings. Exploration of the ocean floor stretched from the New York city dump site off Sandy Hook out to the head of the Hudson Canyon – a deep valley in the continental shelf and slope – and down to the head of the Wilmington Canyon off Atlantic City, N. J. Some scientists believe that canyons such as these may serve as "pipelines" for the movement of sediment and sinkable pollutants from the continental shelf to the deep ocean; the first phase of the project focused on the dynamic processes active in these canyons to determine whether, in fact, sediment is transported along the canyons into the deep ocean and, if so, at what rates.

The second phase of the project – from July 4 through July 13 – dealt with sediment transport on the New York and New Jersey portions of the continental shelf, between the Hudson and Wilmington Canyons. In the first series of dives in this study, undertaken in October 1971, evidence was found that storm currents do move seafloor sediments about and cause slow but unmistakeable changes in the topography of the shelf. These findings challenged one scientific view which held that little has happened to the continental shelf since it was flooded after the ice age. In the second phase, Westinghouse's *Deepstar* 2000 was used to look for evidence of sediment transport along the bottom of the shelf, such as current ripples and areas of bare rock that might have been swept clear of sand and sediment.

In addition to the immediate studies made during the dives, scientists emplaced various kinds of sensors or tracers that will be read out during follow-up dives in September. At various locations along both the Hudson Canyon and the adjacent continental shelf, *Deepstar* 2000 scientists set out current meters on the bottom. Whenever the currents exceed about 20 cm/sec, the meters will record their strength and duration. The Navy's *Alvin* also set out bottom stakes in the Hudson Canyon, to measure sediment slides down the canyon slope. These stakes will again be checked in September and the amount of movement recorded. From *Deepstar* 2000, soluble blocks of dyed sand (about the size of loaves of bread) were placed on the bottom of the continental shelf, with different colored dyes for different sized sand grains. These will be photographed in September to show sediment transport during the intervening three months.

New effluents measurer

The Region VIII Environmental Protection Agency in Denver has begun using a new Varian Techtron Model 635 UV-Vis Spectrophotometer for water and waste effluent analyses across the six-state region, using the instrument in a "mobile lab" trailer-type van. The Model 635 is one of a new line of scanning spectrophotometers suitable for economical studies of waterway effluents and pollutants in lakes, reservoirs and other natural waters. According to John Tilstra – chief chemist for the laboratory services section of the EPA – the new spectrophotometer "has exceeded performance expectations" and has demonstrated a high degree of versatility: "we are required to measure unknown and widely variable concentrations of diverse constituents in everything from sewage digester sludges to mine wastes to natural waters." The principal parameters routinely measured on the Model 635 are: orthophosphates, ammonia, nitrite nitrogen, nitrate nitrogen, boron, selenium and arsenic.

NATIONAL DEFENSE

Navy automatic tracking system

Scientists at the Naval Research Laboratory (NRL) in Washington have developed a systematic approach for the design of a digital automatic tracking antenna system. The new NRL system, which has been developed around present modes of operation, advances the main design criteria of accuracy, reliability, ease of maintenance and minimum cost. An optimum technique to convert from a manual tracking antenna system to an autotracking system is made possible by the NRL-developed special-purpose system controller, automatic control unit (ACU-1) and by the commercial availability of low-cost and accurate digital-to-synchro (D/S) converters.

The NRL-proposed system is designed to relieve the human operator of menial tasks, performed manually in current systems, while taking maximum advantage of his ability to make decisions. The operator prepares a punched-paper tape using an off-line computer, verifying the tape to assure accuracy. Information for two antennas is stored on the tape, and the tape is read by the ACU-1 which reformats and transmits the digital data at specific time intervals to a D/S converter for each antenna. The autotracking process is initiated at a preset time and automatically stops at the completion of the specific task.

Improved Hawk Missile tests

The first Theater Readiness Monitoring Facility (TRMF) for testing Improved Hawk missiles has been delivered to the U. S. Army by Raytheon Company. The TRMF gives the Army a computerized test capability for assessing the status of deployed Improved Hawk missiles on a sample basis. By sample testing under controlled environmental conditions, known variables are eliminated, thereby providing an accurate system trend prediction for the Certified Round Hawk missile in terms of the effects of handling, transportation, storage and aging.

Improved Hawk, which was started in 1964 to incorporate the latest advances in technology, now features a completely redesigned missile with new guidance package, larger warhead and improved motor propellant. Higher reliability is made possible by the use of solid state components throughout. The maintenance burden to soldiers in the field is less because the missile goes directly from the production line to the launcher as a "Certified Round"; no maintenance or test is required by the Army in the field.

RAPID TRANSIT RESEARCH

Electric power "city"

An electric power supply and distribution system equivalent to that for a city of 20,000 persons will be designed by the Jackson & Moreland Division of United Engineers & Constructors Inc. for the U. S. Department of Transportation's High Speed Ground Test Center at Pueblo, Colorado. Employing only a few hundred persons, the new test center "city" will have test tracks, facilities and available electric power for full scale research in high speed ground transportation systems. In planning or under construction at the 50-square-mile site are an 80-mile-per-hour conventional rapid transit test track; a 120-mile-per-hour conventional railroad track; a test track for vehicles with linear induction motors; and a guideway for tracked air cushion vehicles that can hit speeds up to 300 miles per hour. In a related

(Continued on next page)

assignment, Jackson & Moreland are also designing the Wheel/Rail Dynamics Facility Test and Test Support Building to be constructed at Pueblo for full scale testing of rail-borne vehicles simulating the dynamics of speeds up to 300 miles per hour.

EDUCATION

MIT practicing engineer program

The M.I.T. Center for Advanced Engineering Study is now accepting applications for the Practicing Engineer Advanced Study Program – an intensive, in-residence program of continuing education for experienced engineers, applied scientists, technical managers and educators, individually tailored to the background and objectives of each participant. The Program will combine classroom study, seminars, guided independent study and research. All the resources for education and research throughout M.I.T. are available to the Fellows of the Center. The Program is divided into segments which coincide with the M.I.T. summer, fall and spring terms. Participants may start at the beginning of a term or at the beginning of special review subjects offered during the summer. For more information and application forms, write to: Practicing Engineer Advanced Study Program, Center for Advanced Engineering Study, Room 9-215B, M.I.T., Cambridge, Mass. 02139.

New B.A.'s in computer science

Advanced degrees in four related science areas – electrical engineering, mathematics, computer engineering and computer science – have been offered for some time by the University of Illinois, Urbana/Champaign; now, however, the school becomes the first to offer a full spectrum of course work in computer engineering and computer science at undergraduate as well as graduate levels. A B.A. degree in computer engineering was added to the university's curriculum a year ago and undergraduate opportunities are now complete with the addition of the B.A. in computer science.

Computer engineers specialize in the design and construction of computers; computer scientists in their operation and application. With emphasis in different areas, the two curricula involve courses in the engineering college's electrical engineering department and the U. of I. Graduate College's computer science department.

HONORS

Navy commends data-design labs

Data-Design Laboratories was recently presented with a special commendation flag from the U.S. Navy for its "outstanding contribution" to the Poseidon missile program and its "unprecedented excellence" in technical and training support for the program. Clayton E. Evans, engineering manager for the Navy's Strategic Systems Project Office – the nation's Polaris/Poseidon missile agency – presented the flag to Robert Wood, Data-Design Laboratories' vice-president and manager of development for this diversified corporation with more than a decade of experience in research, development, design and production of defense electronics systems.

The Navy stated in its commendation that the recent deployment of the U.S.S. James Madison with the Poseidon weapon system aboard was a "most significant milestone" in the defense of the United States and that Data-Design Laboratories' contribution to the program "in establishing training requirements, personnel performance criteria, and testing methods," as well as a "high degree of management, technical ability and competence," greatly contributed to the Navy's ability to operate and maintain the nationally-vital Polaris/Poseidon weapons system.

BOOKS

New Archer transistor guide

The new Archer Transistor Substitution Guide from Radio Shack Electronics lists 15,000 commercial transistor types which, in most cases, may be directly replaced by one of 29 Archer transistors. Detailed specifications and electrical characteristics for each of the 29 transistors are given in the booklet. 24 of these transistors are custom-made for Radio Shack by Texas Instruments, Inc., and five are imported from a top manufacturer. The 96-page booklet also contains useful information on the care, handling and testing of transistors and important suggestions on their use and replacement. The Archer Transistor Substitution Guide is priced at $1.00 and is available at all Radio Shack stores. Copies of the book are available at no cost to educators in high schools, colleges, technical and vocational schools. These may be requested by writing to Radio Shack, Dept. EP-1, 2617 W. Seventh St., Fort Worth, Texas 76107, on your school letterhead. Please mention *Electronics Digest*.

Using car tune-up testers

"Using Electronic Testers for Automotive Tune-Up," by Albert Wanninger (TAB BOOK No. 604, Cloth: $7.95 – Paper: $4.95), is an all-in-one, profusely illustrated manual providing complete information and operating instructions for all commonly-available electronic devices used for auto tune-up. Wanninger starts with simple voltage and continuity checks, progresses through more involved procedures employing oscilloscopes and specialized testers, and ends with a complete automotive tune-up on console-type analyzers. Contents: Voltmeter and Ohmeter Tests – Battery Charger Tester – Charging System Analyzers – Tachometers and Dwell Meters – Timing Lights – Ignition Advance Testers – Ignition Testers – Ignition Oscilloscopes – Electronic Compression Testers – Vacuum Gauges – Exhaust Gas Analyzers – Specialized Testers and Diagnostic Equipment – Glossary – Index. The manual can be ordered through your book store, or direct from Tab Books, Blue Ridge Summit, Pa. 17214.

MILESTONES

CELEBRATING WESTERN RADIO'S 40 YEARS in the electronic distribution business are (left to right) sales representatives Paul Marquez, Art Fox and John Tunnell, and sales manager Jim Reynolds. Art Effron, district sales manager for General Electric's Electronic Components Sales Department, presents the San Diego firm with a silver coin clock commemorating its four decades in the electronics field.

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APPOINTMENTS

Radio Shack names B. H. Hunter exec v-p

Bennett H. Hunter has been named to the position of executive vice president of Radio Shack, a Tandy Corporation Company, by Charles D. Tandy, chairman.

Hunter, 54, who had been vice president and regional manager of Radio Shack's central region, now assumes responsibility for the establishment and execution of operating policies and procedures for the company's more than 1500 retail stores in all 50 states and Canada.

In announcing the appointment, Charles Tandy stated, "Bennett Hunter is one of the outstanding men in our organization who has contributed substantially to our success and to the development of other men of ability."

Hunter succeeds G. R. Nugent who has joined the executive group of Tandy Corporation.

Hunter joined the Tandy organization in 1960 as a manager trainee, served as a store manager on the west coast, and later became district manager in San Francisco. In 1966 he transferred to the Radio Shack division as a metro manager in Memphis, Tennessee. He became a district manager in 1968 and was appointed vice president and regional manager in January, 1971.

Bennett H. Hunter

Originally from North Carolina, Hunter is a graduate of the University of North Carolina and a veteran of World War II. He and his wife Doris now live in Fort Worth, Texas with their children, Barbara Scott, 24, Bennett, Jr., 14, and Doris Marie, 12.

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SCIENCE PROJECT

Basic Transistor Operation

Transistors require proper sources of voltage to keep currents at a safe value. Output energy must be coupled into some form of load in order to appear at the correct circuit point. Other components must be chosen so power is efficiently transferred from one section of the circuit to another.

An effective way to gain insight into over-all transistor operation is the construction of a simple one-transistor amplifier. As it is adjusted, varied, and measured, the underlying transistor action may be observed. As stated earlier, this is its ability to utilize a small current flowing between base and emitter to control a much larger flow between emitter and collector. Such an amplifier and its construction details are described in this chapter. As the idea of amplification becomes clear, it is an easy matter to modify the circuit so it performs as an oscillator; an important application evolving from the transistor's inherent ability to amplify.

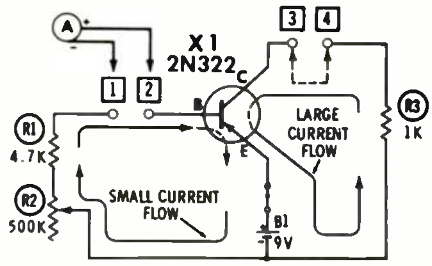
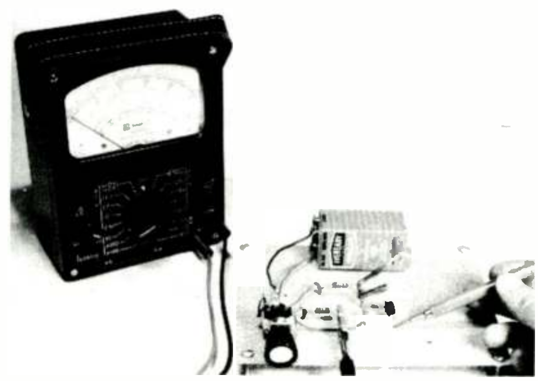


Fig. 1. Common-emitter amplifier circuit.

COMMON-EMITTER AMPLIFIER

The example chosen to demonstrate amplification represents the most widely used circuit configuration; the *common emitter.* This is shown in the schematic of Fig. 1. The name is derived from the fact that the emitter is common to both the input (the section of the circuit that receives a signal) and output (the area where amplified energy appears). The transistor itself is a PNP type 2N322, which is typical of the numerous general-purpose units that are popular among experimenters.

To set up a working demonstration, follow the construction details set forth in Fig. 2 and the following Parts List.



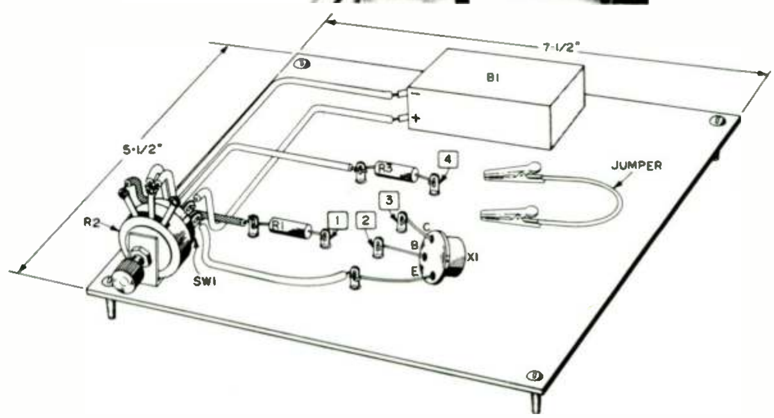


Fig. 2. Pictorial drawing of common-emitter amplifier.

PARTS LIST

R1—4.7K ½-watt resistor (962 B 1800 $.12)
R2—500K potentiometer with switch (961 B 1714 $1.50)
R3—1K ½-watt resistor (962 B 1800 $.12)
X1—2N322 transistor ($.64)
B1—9-volt transistor-type battery (23-464 $.35)
SW1—Switch for R2 (961 B 5400 $.99)
Misc.—Perforated board; circuit push-in terminals (270-1394 $1.59 per 100); battery clips (270-325 $.60/pkg. of 5)

The chassis is simply a piece of perforated board to which various circuit components are mounted. The leads supported by small metal clips, terminal strips or simply threaded through board holes. The potentiometer control is bracket-mounted in one corner by means of a strip of scrap metal. Two connections in the circuit are purposely incomplete. They provide test points for connecting meter leads to measure current flow at the input and output sides of the transistor. Notice that points 1 and 2 allow current readings to be taken at the base of the transistor; 3 and 4 are in the collector circuit. Whenever the meter is connected to measure current at one set of test points, the other set must be shorted. This is done with a small jumper made by attaching alligator clips to both ends of a piece of hookup wire. The jumper may then be shifted back and forth between collector and base, as is the meter.

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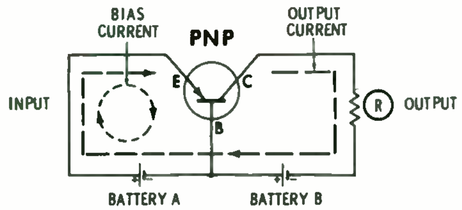

Fig. 3 – Common-base amplifier circuit.

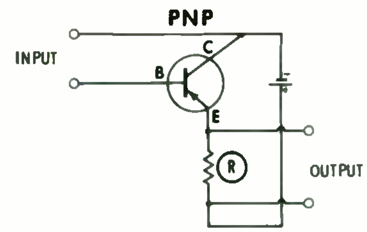

Fig. 4 – Common-collector amplifier circuit.

Caution: Remember that the meter range switch must be changed to prevent slamming the needle. A recommended procedure is to start with the meter on the highest range and then switch to a lower range that provides the best indication.

The meter is a VOM (volt-ohm-milliammeter). It is the most valuable single instrument used by the electronic hobbyist to analyze, adjust and troubleshoot home-built circuits. While a relatively inexpensive VOM is adequate for checking many transistor circuits. the sensitive 20,000 ohms-per-volt model should be considered if the hobbyist contemplates any significant amount of experimentation.

The basic layout of the amplifier contains various elements already described in terms of theory, plus new components which make it a practical circuit. Notice the position of the 9-volt battery in the schematic. The negative terminal can apply voltage to the base through resistor R1, potentiometer R2, and test points 1 and 2. The emitter connects to the positive battery terminal through on-off switch SW1. Thus, the forward bias requirements of a PNP transistor are met. The collector-emitter circuit receives correct bias voltage from the battery. The purpose of the three resistors should become apparent as the circuit is placed into operation. The over-all object is to discover if a small input current to the base circuit will result in a large current flow in the collector circuit. The action may be followed by actually performing the following steps, or tracing out the schematic in Fig. 1.

EXPERIMENT TESTS

First, the meter is set to read at least 100 microamperes, and its negative probe is clipped to test point 1. The positive probe goes to point 2. Test points 3 and 4 are connected with the jumper. Turn on the power by rotating potentiometer R2 and observe the current indicated by the meter. It should be possible to vary the reading from nearly zero up to 90 or 100 microamperes. Note the action of the potentiometer; its slider determines how much resistance, and thus voltage drop, occurs between the base and negative battery terminal. The lower the resistance, the greater the voltage difference there is between base and emitter. As forward bias between these elements is increased, the current in the base-emitter circuit increases. The fixed resistor, R1, serves as a current-limiting device. It keeps a small amount of resistance between base and battery at all times. Otherwise, full battery voltage at the base might cause a current flow beyond the maximum rating of the transistor.

Base currents may now be compared with those flowing in the collector. As a starting point, adjust the potentiometer so 20 microamperes is indicated on the meter. Don't disturb the potentiometer and transfer the meter leads to test points 3 and 4 – positive probe to 3 and negative to 4. Shift jumper to points 1 and 2. Collector current should be on the order of .5 milliampere (500 microamperes). This is only an approximate figure, since wide variations between transistors are normal.

One highly significant conclusion may be drawn from these simple steps: If a base current of 20 microamperes causes the collector to conduct .5 milliampere, then the collector current is approximately 25 times greater than that flowing in the base. This represents the DC current gain of the transistor, more precisely termed *DC beta,* and is a measure of the transistor's ability to amplify. As mentioned in an earlier chapter, the original source of current is the battery. The arrows in the schematic of Fig. 1 point out the principal directions taken by electrons from the battery.

The demonstration circuit can reveal another major characteristic of the amplifier. This is an ability to recreate the shape of the current being amplified. To prove this for yourself, restore the board to its original setup by returning the jumper to test points 3 and 4 and the major leads to 1 and 2. Adjust the potentiometer for a reading of 40 microamperes in the base circuit, exactly double that of the earlier step. If collector current is now measured it will be found to be conducting about 1 milliampere, also double the previous value. A third check can be made by adjusting R2 for a base current of 80 microamperes. In this case, collector current should rise to 2 milliamperes. Thus, it may be seen that the 2N107 not only amplifies by a factor of approximately 25, but does this in a *linear* manner. This is true over a range of input currents which fall within the transistor's normal ratings. Linearity in the transistor in many applications is important. For example, if small voice currents from a microphone are to be amplified, the large output currents from the transistor should bear the same basic shape as the input, or distortion will result.

With the existing setup, a characteristic peculiar to the common-emitter amplifier can be examined. Although a signal passing through a transistor wired in this manner is amplified faithfully, the output is actually a mirror image of the input. A process of *phase reversal* occurs. It is easy to demonstrate. Both test points on the board are jumpered, one with the clip lead already made up, the other with a short piece of bare hookup wire. The VOM is adjusted to read 9 volts DC and the probes connected; positive to the positive battery terminal and negative to the transistor collector. When the power is turned on, the meter reads the voltage between emitter and collector – approximately 9 volts. But, as the potentiometer is rotated to increase base current, note that collector voltage proceeds to drop. It reaches nearly zero when the potentiometer is at full clockwise.

Thus, it may be seen that an increase of negative voltage applied to the base causes a corresponding decrease of nega-

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tive voltage at the collector. In effect, the collector is shifting to an opposite, or in a more positive, direction from that of the base. The net effect is that a negative-going signal applied to a common-emitter amplifier creates a positive-going signal at the output.

COMMON-BASE AMPLIFIER

This arrangement is encountered less often than the common emitter, but finds some application in oscillator circuits. There is no phase change in a signal as it is transferred from input to output of a common-base amplifier, *and current gain is always less than one.* This last statement does not mean that the transistor fails to amplify. Although current may be greater at the input, voltage changes are greater at the output than at the input.

The basic action of the common-base connection is shown in Fig. 3. Note that the base is common to both emitter and collector circuits. Battery A supplies the necessary current to bias the emitter in the forward direction. The other voltage source, Battery B, provides the reverse bias required by the collector. Bias current, indicated by the light arrows, is a relatively small circulation between emitter and base. Tracing the larger circulation of collector current, we find that it also flows in the input circuit, traveling from collector, through the two batteries, to the emitter. Thus, it may be seen that output current also flows in the input. If bias current at the base were made to increase, over-all current would also rise. The load resistor (R) in the collector circuit displays an increasing voltage drop as added current flows through it.

COMMON-COLLECTOR AMPLIFIER

This is the final arrangement in the three basic amplifier connections. The input signal (see Fig. 3) is applied between base and collector. As the signal grows increasingly negative, current flow in the output (emitter-collector) also rises. The direction of the signal at the output is the same as for the input which accounts for the lack of phase reversal in the common-collector amplifier.

IMPEDANCE

This term is used often in conjunction with transistor amplifiers. It is a relationship between voltage and current, as determined by the amount of opposition presented to current flow. In general, where relatively large currents flow, impedance is low. The value is measured in ohms and is increasingly significant when signals must be transferred in and out of the transistor amplifier at maximum efficiency. Optimum power transfer occurs when the signal source has the same impedance as the input impedance of the transistor. Of equal importance is the impedance of the load, which should extract maximum energy from the transistor. It, too, must display an impedance as nearly equal to the transistor's output impedance as possible.

This largely accounts for the application of the three different amplifier arrangements just described. In the common-emitter circuit, input impedance is characteristically low, on the order of a few hundred ohms. The reason is that the base is biased in a forward direction and the opposition, or resistance, to current flow is also low. Output impedance is considered to be medium, a few thousand ohms; the collector circuit is reverse-biased and exercises greater opposition.

The other amplifier arrangements, as a consequence of their current flows, display different characteristic impedances. In the common-base, for example, it is extremely low at the input, extremely high at the output. The condition is exactly reversed in the common collector amplifier – very high input impedance, very low output impedance. Through choice of amplifier arrangement, the designer can choose a configuration which best serves the needs of a particular circuit. It must be realized, however, that there is a limitation inherent in this process since voltage and current amplification are also variable factors. This helps to explain the popularity of the common-emitter amplifier; it yields relatively high gain when considered in terms of voltage, current, or power.

AC AMPLIFIERS

For the sake of simplicity, the transistor has been described here as a device capable of amplifying a DC, or direct current, signal. In practice, however, AC amplification is far more commonplace. The input signal often takes the form of a rapidly changing current flow which alternates directions providing positive and negative values. Fig. 5 illustrates a typical AC amplifier. Note that it is similar to the earlier version of the common-emitter PNP amplifier, except for the addition of capacitors C1 and C2.

Resistor R1 acts as the base bias resistor. Its value is selected so a nominal amount of current results in the collector and through load resistor R2. Collector current at rest is shown by the dotted line marked "Static Current." Up to this point, we have a basic DC amplifier. The current through it is steady and unchanging. The application of an input AC signal alters this condition. This is shown as a varying current shifting between plus and minus at the left. As the AC signal reaches the base (through capacitor C1 which offers no opposition to AC), it will oppose or aid base bias current. When the positive part of the AC cycle is applied, it cancels some of the negative-going bias and current in the collector circuit drops. The opposite effect occurs, when the negative-going part of the cycle adds to the base bias; collector current increases. Therefore, collector current is made to vary in strength around its static, or resting, value. Notice that output current is an accurate reproduction of the AC input, though much larger in amplitude, or strength. There is the phase change, which typifies the common-emitter amplifier, but it is of little concern in this application.

The function of the two capacitors in the circuit is to preserve the operating biases applied to the transistor by the battery. Capacitors have the ability to block steady DC, while presenting little opposition to a varying (AC) signal; thus the original biases cannot be lost through the input and output pathways.

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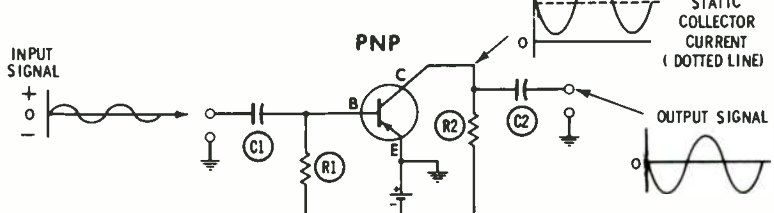

Fig. 5 – Basic AC amplifier circuit.

An examination of the amplified output reveals an interesting phenomenon. Notice that the waveform of the collector signal lies completely above the zero current line. Although it is a recreation of the input, it has been changed from AC to pulsating DC. This occurs since the signal is, in effect, a changing of static collector current, which can only flow through the transistor collector-emitter circuit in one direction. The output capacitor passes pulsating DC in much the same manner as the original AC input. DC is blocked and the zero reference is preserved.

The next section presents a description of how you can construct a practical amplifier to illustrate these principles just discussed.

AC AMPLIFIER EXPERIMENT

The common-emitter circuit in Fig. 1 is readily converted to a demonstration model for AC amplification. The additional items needed are:

(1.) a .1-mfd tubular capacitor
(2.) one earphone, 1,000-ohm magnetic type
(3.) additional hookup wire

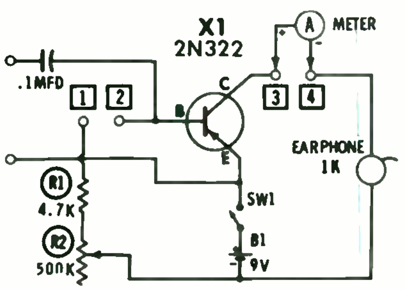

Fig. 6 – Practical AC amplifier circuit.

The altered circuit is shown in Fig. 6. The AC signal to be amplified can be obtained from the speaker leads of a radio (or phonograph). Connect two lengths of hookup wire to the terminals of the speaker and bring them near the circuit board. As a preliminary test, connect the earphone to the ends of these leads and listen to the signal. The radio volume control should be left at a low level throughout these steps, providing just enough volume to be barely audible in the earphone. If you find it difficult to differentiate between the sound from the radio speaker and that from the earphone, disconnect one speaker lead, being certain that it is rejoined to the piece of hookup wire.

Next, wire the earphone into the collector circuit of the transistor to serve as a load. (The 1,000-ohm resistor used for the earlier demonstration should be removed completely during this step.)

Set the VOM to read approximately 1 milliampere of current and connect its probes to test points 3 and 4. (Observe the polarity given in the schematic.) Once the on-off switch is turned on, the potentiometer which controls base bias is rotated for a collector current of exactly 1 milliampere. This amount of current establishes a Class-A mode of operation for the transistor.

Now the signal may be applied to the input. Note that this is introduced through the .1-mfd blocking capacitor fastened to the base of X1. The other input connection is the piece of hookup wire to the emitter.

Listen in the headphone – the volume of the program should sound considerably louder than when it was obtained directly from the radio. If there is distortion, lower the volume control setting on the radio to avoid overloading the transistor input. (This is best accomplished while listening to a voice program.)

In addition to the concept of amplification, the circuit demonstrates other characteristics. Note that the meter needle, which is indicating collector current, remains fixed at 1 milliampere while the program is being amplified. Although the input AC signal is causing a great fluctuation in collector current, this occurs above and below the 1-ma static collector value. The needle cannot move at the rapid audio rate of the program and therefore settles down at the average 1-ma value. This current level remains the same no matter what the level of input signal, as determined by the radio volume control setting. It is, of course, possible to overload the transistor by increasing the input beyond the current-handling ability of the base circuit.

EDITOR'S NOTE: The foregoing article was reprinted in part from an outstanding little handbook entitled Understanding Transistors and Transistor Projects. It provides a practical introduction to the "inner workings" of the transistor in a number of interesting circuits which can be built at school or at home. It explains basic transistor circuitry and then brings this knowledge to life with a series of experimental and practical projects. The handbook is available at Radio Shack Stores throughout the U.S. and some areas of Canada. Its cost is listed at 95 cents.

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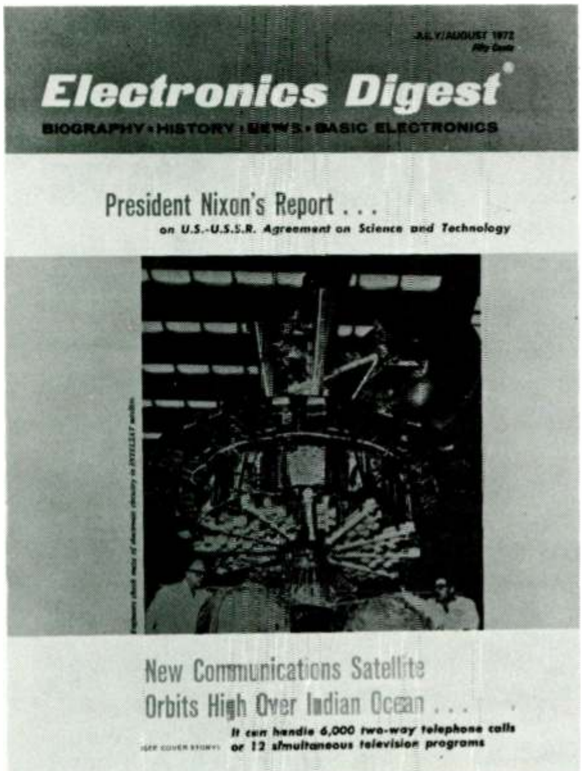

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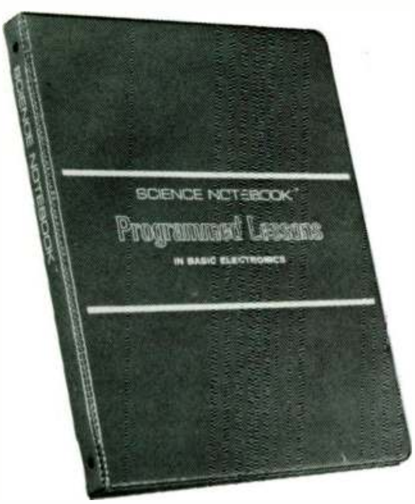

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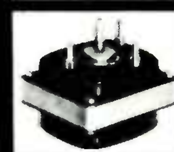

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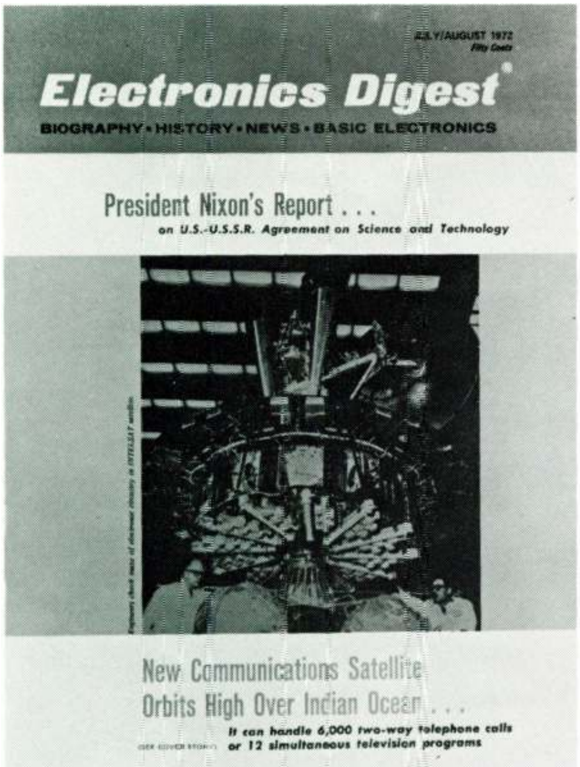

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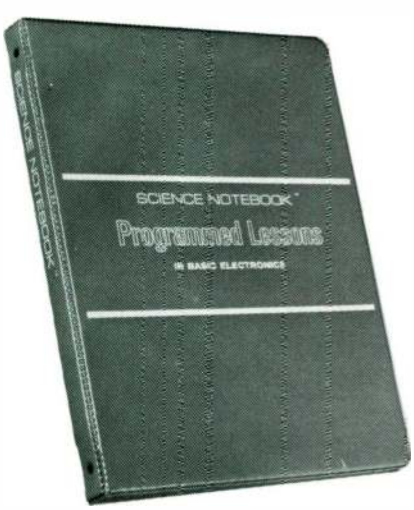

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