GOLDEN ANNIVERSARY ISSUE

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WR... UNDERSTAND IT

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35 CENTS

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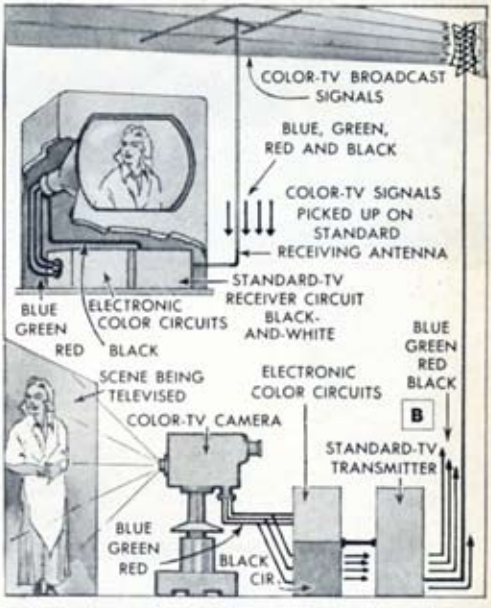
COLOR TELEVISION *Today*

ALL-ELECTRONIC color television, fully compatible with the present standard black-and-white system, has made rapid strides in the past two years as demonstrated in recent field tests. Owners of TV sets in the New York area responded favorably to reception of the RCA color programs in black-and-white. A new RCA experimental color-TV receiver appears in photo A. NBC studio shots, and outdoor scenes, photo D, were picked up by the color cameras during the tests. In the RCA color-TV system the equipment is all-electronic—at the studio, transmitter and receiver as illustrated in sketch B.

Late in September a new contender made a thrilling entry in the color-television field with a handmade experimental model of a compatible all-purpose TV picture tube. Basically it employs the same idea as the RCA color tube—but simplified. The inventor, shown with the new tube in photo C, is Prof. Ernest O. Lawrence, atomic physicist at the University of California and the inventor of the cyclotron. The tube employs a wire grid for color switching, and automatically switches from one system to another. Experts say that, if it proves successful, the tube can be mass-produced at comparatively low cost.


A

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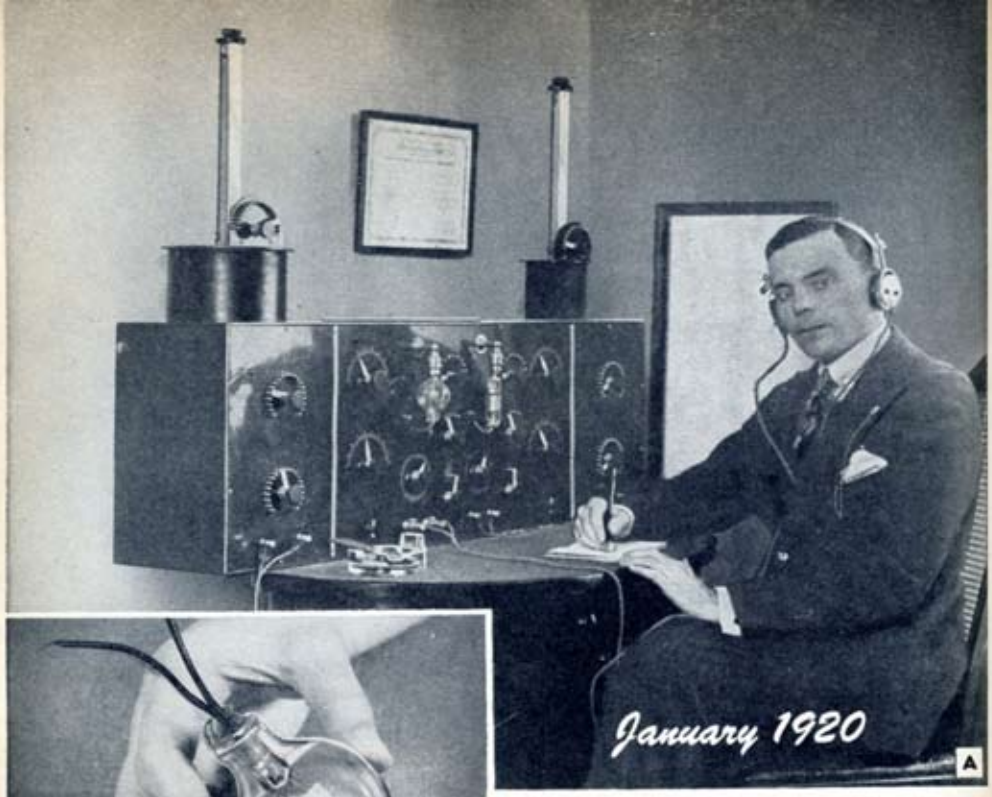
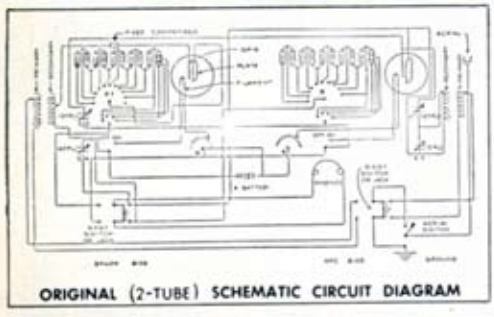
D




ORIGINAL (2-TUBE) SCHEMATIC CIRCUIT DIAGRAM

Popular Mechanics

FIRST RADIO and TELEVISION RECEIVERS

FOR EXPERIMENTERS

By Frank L. Brittin W9DCX

PERHAPS there is no better way to make us realize and appreciate the convenience, entertainment and educational value of today's radio, television and electronic devices than to take a quick look at some early models. *Popular Mechanics Magazine*, now celebrating its 50th Anniversary, was a pioneer in keeping readers informed about these comparatively new modern arts that have developed so rapidly.

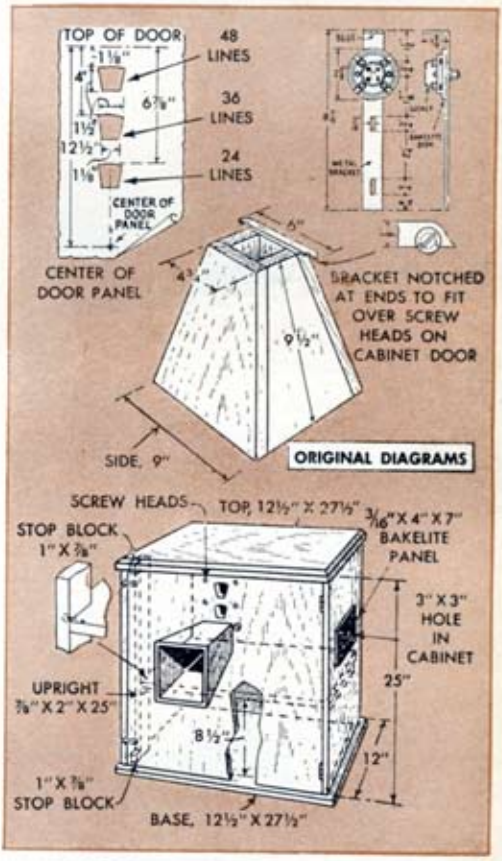
Today we can put radio receivers in our pockets — but the first vacuum-tube receiver ever described in *Popular Mechanics Magazine* for construction by experimenters was 9 in. deep, 14½ in. high, 41½ in. long and employed only two tubes. It appeared in the January 1920 issue. For photo A above, the caption read, believe it or not, as follows: Taking up Only a Small

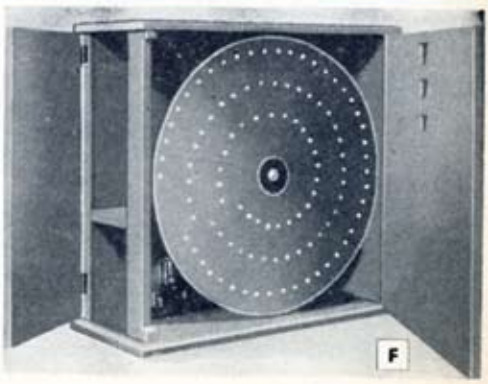
Amount of Space in the Corner of the Room, the Cabinet is an Inconspicuous Article of Furniture, and if Properly Finished, may be a Real Ornament. However, in those days it was considered to be a keen performer, bringing in long-wave signals from IDO (Rome, Italy), POZ (Nauen, Germany) and YN (Lyons, France), as well as from the American stations such as Sayville, Arlington and others. It also tuned in the short-wave ham band. This was, of course, all "wireless telegraphy" as voice broadcasts did not come until later.

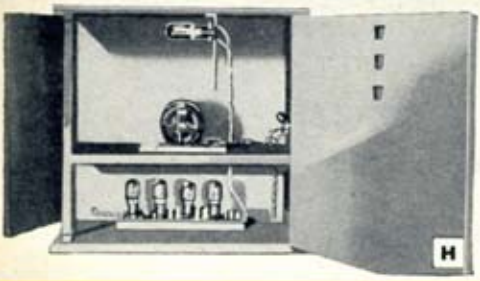
A 6-volt storage battery provided the A-supply; the B-battery consisted of two banks of 10 flat-type three-cell flashlight batteries. The two-tube circuit employed a $7.50 DeForest Audion tube, photo B, (known to the "wireless fraternity" as an "apple" tube), and one $5.00 Audio-Tron tube. Both the primaries and secondaries of the large couplers (tuning coils) were multitapped. The elevator devices for raising and lowering the secondaries were lead counterweights operating on pulleys; the antenna used was a single wire, 160 ft. long.

The builder of all of the receivers shown was a Radio Operator, Commercial First Grade, license No. 14540, and also a radio "ham." *Popular Mechanics'* radio section continued to keep its readers informed of every improvement in this rapidly advancing art. Soon, voice and musical programs were available and five years later, in the February and March 1925 issues, an "eight tube superheterodyne receiver" was described for construction. This popular student receiver, photo C, was housed in an attractive homemade cabinet and used a loop antenna. Radio quickly became an ideal cooperative hobby for father and son. A surprising number of the outstanding radio and electronic engineers of today will tell you that they began by building and repairing radio sets and electronic devices at home for fun. From these early days to the present time *Popular Mechanics* has been one of the chief feeders of new students to the large radio and television training schools.

Television started to show promising

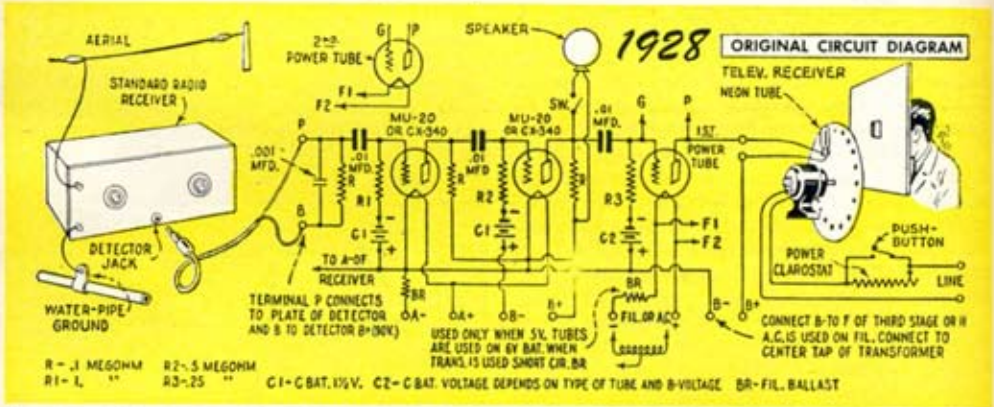






possibilities in large laboratories in 1928. Experimental television programs were on the air in New York, Chicago and Los Angeles in 1928 and 1929. These were rather crude efforts as measured by today's standards. TV engineers of the 1920s used Paul Nipkow's idea of the 1880s for scanning pictures with a perforated spinning disk. These scanning disks, and a neon lamp, or "tube," used with them, photos E and G, were made available in 1928. They were used in *Popular Mechanics'* experimental television receiver construction article that appeared in the December 1928 and January 1929 issues. Photos D, F and H show various views of this receiver, which, with the aid of a condenser lens, gave a pinkish picture about 3 in. square. The original cabinet and circuit diagrams are reproduced. Three perforated spirals in the scanning disk, and corresponding openings in the cabinet, permitted the operator to tune in either 24, 36 or 48-line pictures.

Today we look forward to peacetime all-electronic, three-dimensional color television, and radio astronomy.



Dawn of the Electronic Age

Lee deForest writes of the electronic age, which began in 1906 when he invented the three-electrode tube

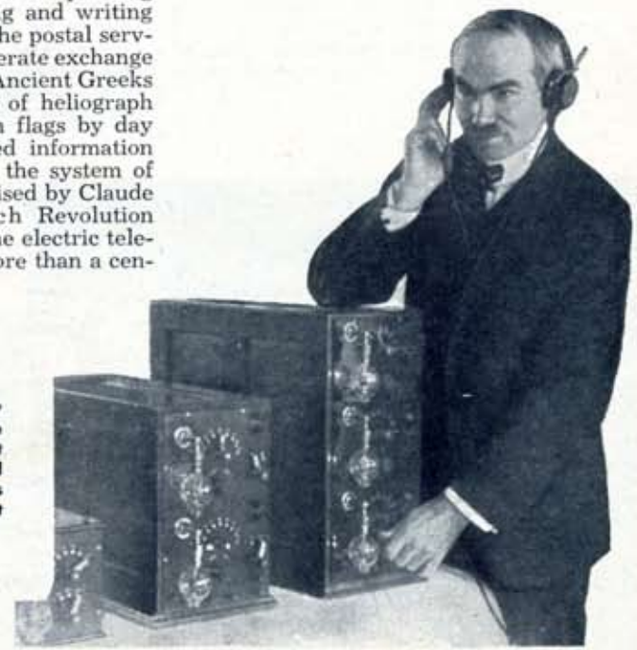
With the giant antenna, at left, Army Signal Corps engineers made the first radar contact with the moon in 1946, only 40 years after the electron tube was invented by the "Father of Radio"

DeForest's patent of a "device for amplifying feeble electrical currents" is one of most valuable ever issued

By Lee deForest
("Father of Radio")

WHEN VOCAL SOUND first became articulate the ancestor of man leaped suddenly from the dumb shackles of the brute. The first crude sign writing, whereby thoughts might be recorded, helped to bring scattered men and tribes into social units and establish contact with future generations through the permanency of the written word. For ages, ecclesiastics maintained a monopoly of reading and writing. Then came movable type and the printing press of Gutenberg. Reading and writing became common heritage. The postal service followed, fostering a moderate exchange of thought between people. Ancient Greeks developed a crude method of heliograph for military signaling. Then flags by day and fires by night conveyed information over wide distances. Later, the system of signaling by semaphore devised by Claude Choppe during the French Revolution blazed the path leading to the electric telegraph of Morse. Scarcely more than a century ago came the first telegraph, an instantaneous means for communicating over great land distances, followed by the submarine cable for spanning the oceans. Bell, experimenting with a new form of telegraphy, came upon the telephone, and as a result business and social life were immeasurably increased in tempo.

Late in the 19th century, wireless telegraphy entered the communications field,



Right, from the crude sets of early radio (three are seen here with the Audion tubes mounted on their front panels) to the magic of radar and television, the electron tube has been the heart of each instrument

U. S. Army photo

Above, halfway up a Korean mountain, this Army radio operator uses a complex VHF receiver-transmitter. Left, his 1904 counterpart takes down a radio message on an early receiver at Fort Mason

first as a means of spinning threads between ships and shores, and robbing the sea of its sinister silence; later as a practical means of transoceanic communication. Inspired by the classical formulas of Maxwell in England, Hertz in Germany in the 1880s discovered electromagnetic waves, proving them akin to light waves but of vastly longer wavelengths and lower frequencies.

Although signaling by means of these hertzian waves, generated first by a condenser discharge across the crude spark gaps of Hertz, Marconi, Lodge and others, and controlled by the telegrapher's key into dots and dashes of the Morse code, preceded by 10 years the advent of the radio tube, those historic crudities could scarcely be considered as properly belonging to the electronic age.

By common consent today, that era was born with the discovery that electrons traveling across an evacuated space could readily be controlled by a simple grid electrode interposed between the electron emitter, a heated cathode, and a cold plate connected to the positive terminal of a battery, preferably of low voltage, its negative electrode being connected to one end of the filamentary cathode. In that so-called "B," or secondary, circuit was inserted a signal-indicating device, usually some form of telephone receiver; later a loudspeaker was used.

Below, Dr. Vladimir Zworykin and a reflected-image television set he made in 1929. Left, today's TV cameras are literally jammed with electronic tubes and parts

In 1916, DeForest went aloft in this plane, making what is said to have been the first time radiotelephone was used in a plane. It was so successful the Army ordered two sets

The date of my discovery of this small acorn from which has sprung the gigantic oak that is today world-embracing, was the latter months of 1906. But it was not until 1912 in Palo Alto, Calif., that the Audion was used as an amplifier, first of radio signals, then for long-distance telephone communication. This rediscovery was made just in time to render possible the fulfillment of A. T. & T.'s contract with the Panama Pacific World's Exposition to establish transcontinental telephone service between New York and San Francisco before January 1915. Later that year the Western Electric Company, now further licensed under the Audion-amplifier patents, succeeded in transmitting by radiotelephone the human voice from Arlington, Va., to the Paris Eiffel Tower, and also to Honolulu, more than 6000 miles distant.

This gigantic step in radio speech was made possible by the discovery, also in Palo Alto in 1912, that the Audion amplifier, when properly connected in a "feed back" circuit, became an oscillator or generator of alternating currents of practically any frequency, numerically dependent upon the dimensions of the circuit elements that were involved.

That invention of the oscillating tube and circuits began forthwith to force into disuse the spark-gap, open, rotary, or quench types, and also high-frequency alternators. Today the use of the tube oscillator is universal, found in every radio and television station for the generation of long, short, or "ultra short" waves around the world.

No greater influence has been at work in molding our civilization than the telephone. Today we have some 50,000,000 telephones installed throughout the world, connected

U. S. Navy photo

Westinghouse photo

Above, two early experimenters in the beaming of radio waves use a highly polished reflector behind an antenna. Experiments such as these led to the subsequent development of the radar

Crude as its beginnings were, radar is today complex beyond the understanding of the layman. Some radar antennas on the island of the U.S.S. Hornet give a clue as to its value

by some 100,000,000 miles of wire and unnumbered miles of "etheric" linkage. And in all telephone lines today longer than 50 or 75 miles you will find electron "booster" tubes so that one can speak from Los Angeles to Paris with the same voice volume as used in local calls.

The actual poetry of this engineering triumph was first brought stunningly upon me in 1915 when I sat in an audience in San Francisco and heard the breaking of the surf upon the far Atlantic shore. There our modern sophisticated generation was able to appreciate for the first time the deep significance of that historic phrase, first signaled over Morse's wire: "What hath God wrought?"

During its early years there was every indication that radio would be employed mainly for military purposes. The Navy and then the Signal Corps were for years its chief proponents. Then the widespread clan of radio hams, or amateurs, tiring of dot-dash conversation reached eagerly for the new implement, the Audion, and soon global conversations began. It was such hosts of young pioneers in the short-wave ocean of space, after the long waves were officially denied them, that demonstrated the unexpected ability of such high frequencies to span the globe and to reach out into empty space. Thus instructed, every effort was hastened by the radio engineer to speed up transoceanic service. Soon we had fast facsimile, followed by unbelievably accurate transfer of photographs.

Today photographs, drawings, fingerprints, printed matter, handwritten and typed messages, business and legal documents are flashed across the sea in facsimile form and accepted at their face value. Thus a new business day opens when a person in New York can sign his name to a document in Japan or Berlin within the hour.

The microphone-amplifier-loudspeaker combination is having an enormous effect on our civilization. Not all of it is good! Consider to what heights of impudence and tyranny, and to what depths of moral depravity, has radio broadcasting and the loudspeaker attained in that recent monstrosity, Transit Radio, Inc. Almost incredible is the loathsome fact that already in 21 cities bus riders must listen to never-ending, blatant advertising and unwelcome jitterbug and bop music, "viciously repugnant to the spiritual and intellectual assumptions of American life," as Prof. Charles Black of Columbia University wrote. This outrage is unquestionably the all-time low to which radio broadcasting can sink.

Such crimes notwithstanding, it is questionable whether science has contributed in one single instance more to present and future civilization than it has in the gift of broadcasting. In 1907 I began to build radiotelephone transmitters for the United States Navy. In testing these devices I placed their output "on the air" and played phonograph records by the hour. The tests attracted widespread attention and gave me the idea of mass communication or "broadcasting." Three years later Caruso's voice was broadcast from the

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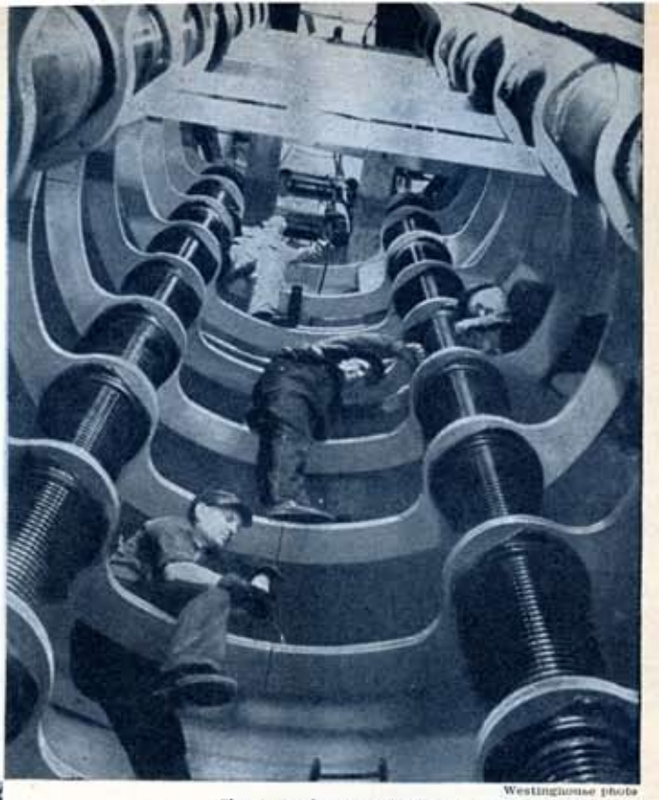
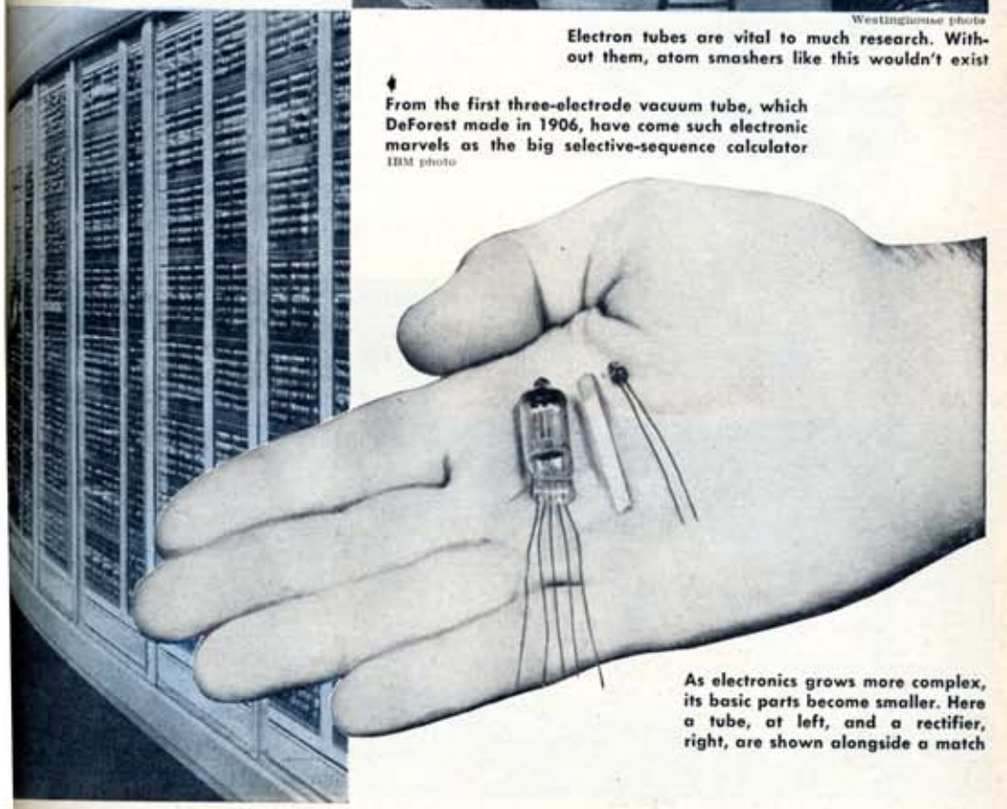


Westinghouse photo

Electron tubes are vital to much research. Without them, atom smashers like this wouldn't exist

From the first three-electrode vacuum tube, which DeForest made in 1906, have come such electronic marvels as the big selective-sequence calculator

IBM photo



As electronics grows more complex, its basic parts become smaller. Here a tube, at left, and a rectifier, right, are shown alongside a match

Dawn of the Electronic Age

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stage of the Metropolitan Opera House. Other stars followed. I continued my broadcasts until 1917, then resumed after the war, first in New York, later in San Francisco. Then broadcasting struck the public fancy. It spread swiftly. First came the programs on the air, then the public urgently seeking equipment to listen in. There began the growth of the multi-billion-dollar radio industry as we know it today, with some 2000 transmitters and 50,000,000 receivers in day-and-night operation. Business soon saw here a wonderful medium for the commercial "good will" message (too frequently, crass commercial advertising breeding anything but good will) and so generously sponsored the programs that today sales of AM-station franchises are frequently reported in the millions of dollars.

A melancholy view of our national mental level is obtained from a survey of the moronic quality of the majority of today's radio programs. So few of the owners of radio stations or the sponsors of their programs realize their unequaled opportunities for uplifting the cultural level of our public. Neither the church nor the public school has so powerful an influence over the mass mind of America. There are many outstanding exceptions to the average mediocrity, like the programs of the "music stations," and educational programs. The same may be said regarding the television stations now operating. The engineers and scientists have done a most outstanding, almost miraculous, job in giving us the marvelous electronic-television system of which all Americans may well be proud.

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But many who are given to use this splendid instrument are so clumsy, so stupid, so shamefully dull-witted.

As though the present refinements of black-and-white TV were not sufficiently marvelous, television engineers have now in readiness for public approval two systems of color. One by CBS has had the too-hurried approval of the F.C.C., an approval upheld recently by the Supreme Court. It is mechanical, uses a whirling tri-color disk, is limited in size to a 10 or 12-inch picture, is incompatible, so that even in black and white not one of the existing 15,000,000 receivers can reproduce the picture without an adapter gadget. By contrast RCA has an all-electric system, not limited in picture size and wholly compatible. Every existing receiver can reproduce that picture in black and white. It is clear which of these two systems will be more patronized by the advertising sponsors! The choice made here by F.C.C. is therefore one of today's outstanding marvels of bureaucratic bungling. National welfare demanded no such haste!

In four years World War II gave to electronics a stimulant and boost which 15 years of peaceful development might not have produced. The foremost development was radar; then came sonar, loran, the proximity fuse, the guided missile, the blind-landing systems for aviation, ground altimeters, ground-speed indicators, automatic pilots, as well as a hundred less-spectacular electronic devices within the inner working of today's airplane. Today's surging preparation of more complicated weapons for defense and offense is finding hourly new uses for, and new forms of, that Promethean device, the grid tube—evacuated or hydrogen filled.

At one time in 1906 I held in my coat pocket the entire world's supply of three-electrode tubes, two in number. Last March the month's output of small receiving and amplifying tubes reached the astronomical figure of 42,400,000. All in one man's lifetime! Such is the progress of science and technology in free America in this mid-20th century.

The old, long-waged, unsuccessful battle of wireless telegraphers for static suppression led Edwin Armstrong to his frequency-modulation system, an old idea long discarded as impractical. Since that accomplishment we have had a new growth in broadcasting transmitters in friendly competition with the old AM stations. Both systems have their special merits.

In the vacuum-tube amplifier, in whose operation the grid (by controlling the B current) is itself the key, reside most of

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the present and future possibilities of electronics. Space permits only the briefest mention of some tubes and their uses. A compact maze of diode elements may constitute an electron-multiplier tube having an amplification factor of several thousand, in a tube the size of your finger. Such tubes are indispensable in the image-orthicon TV camera that "photographs" electronically your favorite television program.

I can merely mention today's employment of "counter" tubes, the basis of all computing machines, solving in seconds complex equations which would require months of tedious mathematical analysis, but basically employing the old Eccles-Jordan "tick tack" circuit, useful in the instantaneous advance computation of the course of projectiles.

The oscillating tube has a hundred uses beside those of radio transmission, as in diathermy (physical therapy), plastic molding, metal fusing, welding, tin plating and plywood manufacture. The cyclotron, synchrotron and bevatron, atom-smashers, generating up to a billion volts, depend on high frequencies generated by the oscillating vacuum tube. Thus has this tube ushered in the atomic age. Now we have the protective radar barrage triggered with megawatts of pulse energy generated by a grid-controlled hydrogen-filled tube to protect us from a future Pearl Harbor! What more important achievements can one ask for the grid to perform?

With grids working half-time only we have the thyrotron, ignitron, using mercury vapor and argon, hydrogen or helium gas, carrying thousands of amperes in some sizes. Electronic devices control high-speed wrapping of packages, fill bottles to the proper level, remove slate from coal at the mines, level elevators, open doors, detect smoke and fumes, measure vibrations and thickness, cement, select and count, saving man from limitless hours of tedious toil. The traveling wave amplifier of ultrashort waves and the transistor will more and more supplement, but never supplant, the Audion.

As a growing competitor to the tube amplifier comes now the Bell Laboratories' thermistor, a three-electrode germanium crystal of amazing amplification power, of wheat-grain size and low cost. Yet its frequency limitations, a few hundred kilocycles, and its strict power limitations will never permit its general replacement of the Audion amplifier.

In optical engineering the combination of a phototube and the electron amplifier tube is omnipresent, indispensable. It makes possible the talking motion picture

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as well as television, measures the energy of stars infinitely distant from our telescopes. The electron microscope, with magnification of 25,000 diameters, makes visible the infinitesimal universe.

As to the future of the electronic age we can foresee a multiplication and extension of every discovery and development which these first 45 years have revealed. In detail: I foresee great refinements in the field of short-pulse microwave signaling, whereby several simultaneous programs may occupy the same channel, in sequence, with incredibly swift electronic communication; vastly important developments in microwave technique, whereby present clumsy connecting leads between wall or floor sockets and electric devices like toasters and vacuum sweepers may become unnecessary; gigantic magnetrons and klystrons, or their successors, will generate megawatts in microwaves; living rooms and their occupants will be heated by high-frequency waves from walls or ceilings; short waves will be generally used in the kitchen for roasting and baking, almost instantaneously, with far better results than in the past; insect pests will be eliminated by like means; bacteriological and biological research will be enormously advanced by short and microwaves of selective frequencies; plant growth amazingly hastened and improved by similar means.

Automobile collisions will be rendered impossible, or unlikely, by radar-controlled brakes and warning signals. By means of the radio space-analyzer, or "telescope," astronomers' knowledge of our universe will be vastly widened. (I do not foresee "spaceships" to the moon or Mars. Mortals must live and die on Earth or within its atmosphere!)

In yet more remote decades electron physiologists will solve the mysteries of biologic "wave emanations," akin to but very different from hertzian waves of any form or frequency, so that radiated "thought or brain waves" may be picked up at some distance, transformed into electrical phenomena, analyzed, measured in units, eventually to make a definite science of the transference of brain and body radiations and emotional disturbances; so that joy and grief can be measured in definite, quantitative units! Eventually, a professor may be able to implant knowledge into the reluctant brains of his 22nd-century pupils. What terrifying political possibilities may be lurking there! Let us be thankful that such things are only for posterity, not for us.

As is eloquently engraved in stone on the National Archives Building in Washington: "What's Past Is Prologue."