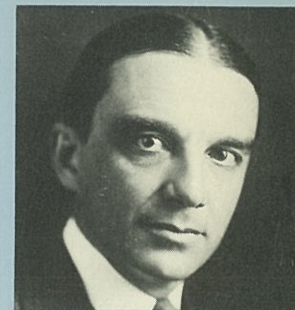
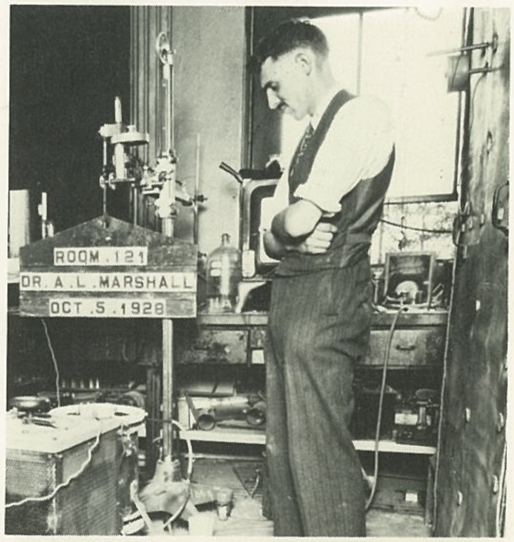
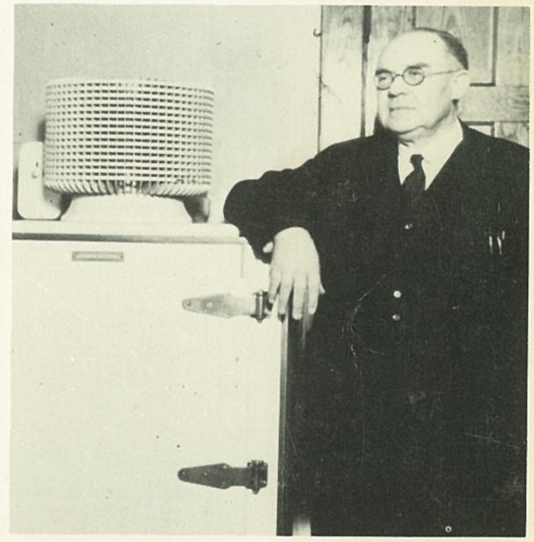
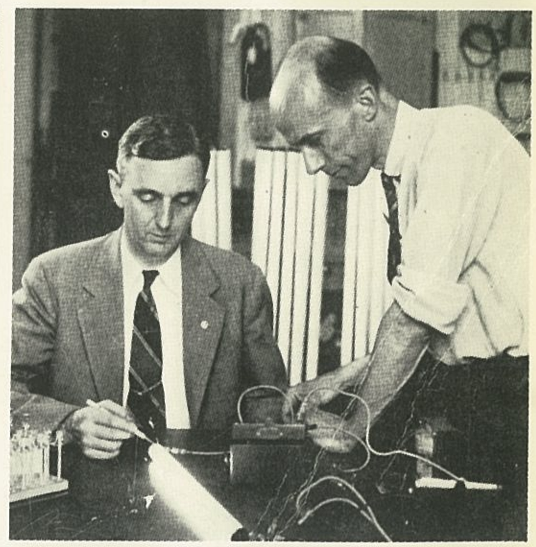
ON THE SHOULDERS OF GIANTS 1924-1946









The General Electric Story
Volume III

An Elfun GE Hall of History Publication

A Photo History

ON THE SHOULDERS OF GIANTS

C. Abbot • E.F.W. Alexanderson • P.L. Alger • W.R.G. Baker • G.B. Benander • B.L. Benb

K.B. Blodgett • W.E. Blowney • C. Concordia • S. Dushman • T.A. Edis

THE ELFUN SOCIETY

An organization of present and retired employees of the General Electric Company, dedicated to the encouragement of cooperation, fraternity, and good fellowship and to the betterment of the community in which they function.

The Hall of History, which is sponsored by the Schenectady Elfun Society Territorial Council, is a multi-faceted project designed to serve as a focal center for the gathering and display of valuable historical documents and memorabilia about General Electric people, products, places, and to share this heritage with America.

W.L.R. Emmet • G.E. Emmons • C.E. Eveleth • G. Faccioli • E.J. Flynn • C.M. Fo

A. McK. Gifford • C.A.B. Halvorson • E.S. Henningsen • L.E. Hildebrand • A. How

Nichols
April '81

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. Junggren • K.H. Kingdon • C.J. Koch • G. Kron • C.H. Lang • I. Langmui

ON THE SHOULDERS OF GIANTS 1924—1946

Pioneering in a New Era

THE GENERAL ELECTRIC STORY
A Photo History Volume III

Schenectady Elfun Society
Territorial Council
Schenectady, New York
February 1979

S. Lee • H.A. Liebhafsky • A.L. Marshall • H. Maxwell • K.B. McEachron • W.L. Merrill

A. Milton • C.A. Minor • W.S. Moody • S.A. Moss • R.C. Muir • L. Navias

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FOREWORD

"On the Shoulders of Giants — 1924-1946" is the third volume in a series of Elfun Society Hall of History publications relating the history of the General Electric Company. Volumes 1 and 2 were entitled "The Edison Era" and "The Steinmetz Era," respectively, in honor of the men whose names have historically been associated with the growth of the Company during the first half-century of its existence. The choice of a title for Volume 3 presented no such clear-cut opportunity. With the death of Steinmetz, no single individual was again to epitomize in the eyes of the public the accomplishments of the Company or the brilliance of its technical contributors. Anyone who has read of Swope, Young, Alexanderson, Moss, Coolidge, Whitney, Warren, Steenstrup and a host of other GE personalities of the period knows that this was not due to lack of deserving talent. Rather, it was due to a proliferation of men and women of diverse talents who were to help sustain the Company during some of its most trying years and to pioneer paths for its growth in a new era.

In a letter to the physicist Robert Hooke, in 1675, Sir Isaac Newton, commenting on his own scientific accomplishments, wrote:,"If I have seen further (than you and Descartes) it is by standing upon the shoulders of Giants." Thus, a great scientist paid tribute to his contemporaries and to those who contributed to the body of knowledge from which he had made his contributions. His words trace their origins to the writings of the Roman poet, Lucan, sixteen centuries earlier, and their implications are universal. The evolution of ideas, of enterprises, and indeed, of civilization, is pioneered by individuals who, "standing upon the shoulders of Giants," become Giants in their own right. This photohistory and chronology is dedicated to the Giants of General Electric, heralded and unheralded — and to those who helped them translate their visions to reality.

February, 1979
Schenectady, New York

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GE Hall of History

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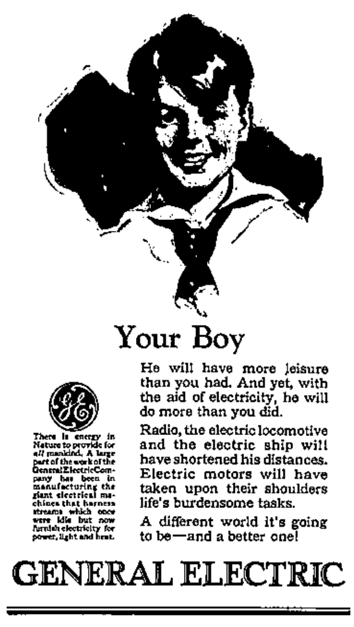
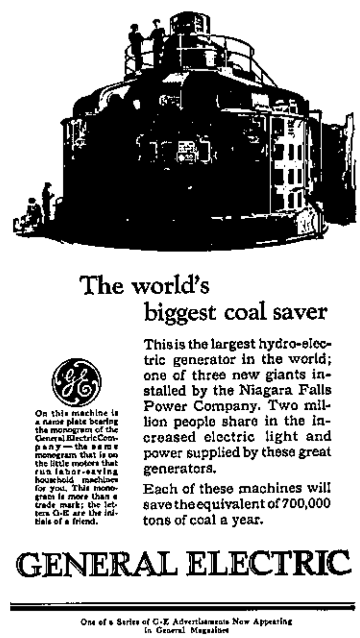
INTRODUCTION

In 1922, when Owen D. Young and Gerard Swope took over the leadership of General Electric as Chairman of the Board and President respectively, about three quarters of the Company's business was in capital goods equipment used by utilities, industrial plants and transportation systems. Incandescent lamps, electric fans and a few small appliances made up the bulk of the remainder. Large appliances such as Hotpoint's stoves and Fort Wayne's electric refrigerators were luxuries which only a few could afford.

Swope and Young recognized the need for diversification, and they recognized that there would be a greater demand for household electrical goods if ways could be found to produce them at lower cost while offering improved convenience and greater reliability. They also realized that electrification of the home would increase the demand for electricity with a resultant growth in the sales of generating and distribution equipment. Supported by the encouragement of the new leadership and the commitment of financial resources, GE people pioneered a multitude of new and improved products for the home and for industry.

Others were at work designing and building bigger and better generators, turbines, transformers, switchgear, and motors — the relatively new workhorses of manufacturing and transportation. They were supported by a greatly expanded group of application engineers whose familiarity with the workings of the industry they served resulted in improved response to the needs of the customer and development of "an Electrical Consciousness" which was to revolutionize the operations of virtually every segment of American industry. A vast network of apparatus service shops spread throughout the country to repair and refurbish equipment rapidly and with minimum inconvenience to the users.





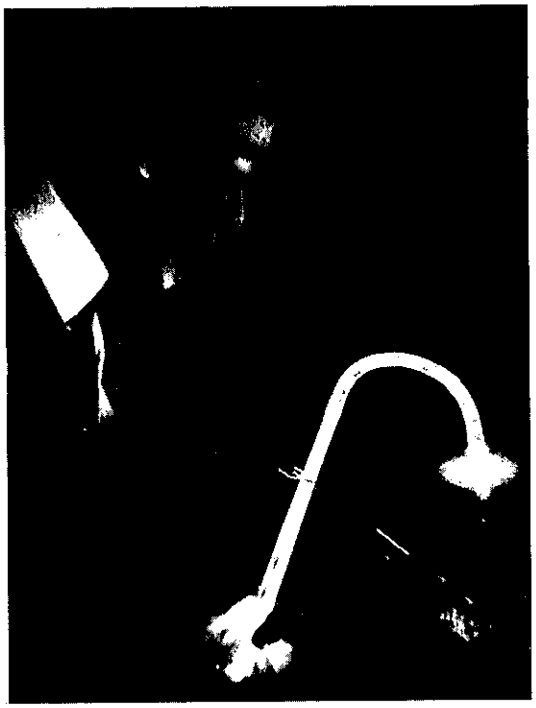
An entirely new distributing organization was developed after the decision to enter the appliance business was made. Strong national advertising campaigns were mounted and made use of the new media of radio broadcasting which had been pioneered by GE stations on the east and west coasts. Swope, who had been the first president of the International General Electric Company, strengthened that organization, and his successors saw to it that GE's products gained worldwide acceptance. In a report to stockholders on March 14, 1940, on the occasion of the retirement of Owen D. Young and Gerard Swope from active leadership of General Electric, Philip D. Reed, Chairman of the Board, and Charles E. Wilson, President, wrote:

> "The period of their administration encompassed two distinct eras — one of seemingly limitless expansion, and one of prolonged depression. Each brought problems of great magnitude for which there were few precedents to serve as guides. Possibly, no better tribute as to how they met the many and diverse problems brought about by ever-changing conditions can be given than that contained in the January, 1940 issue of the magazine, *Fortune:* 'When one recalls the storms through which they had to navigate their super-company, the magnitude of their accomplishments can be appreciated'."

The challenges facing this leadership team were far from over, however. In little more than a year, America was to be thrust into World War II, and the country would be fighting for its survival. Swope and Young were called out of retirement to head the Company while Wilson and Reed served in important government posts.

Thus, there were *three* distinct eras encompassed by the Swope-Young administration. The cornerstones of their accomplishments were the genius, imagination, daring and dedication of the pioneers depicted here and of the countless others whose contributions cannot be covered in any single volume.

1924



Reading a newspaper by light transmitted through a fused quartz rod.

Stage directions for this scene from William Vaughn Moody's play, "The Great Divide," call for a woman's muffled scream, a pistol shot, and the crash of breaking furniture. The microphone on the right sends them all to your home.

An Exciting Evening

Here are four of the WGY Players (the world's first radio dramatic company) at a thrilling climax which almost turns sound into sight.

Tune in, some evening, on one of their productions. You will be surprised to find how readily your imagination will supply stage and setting.

WGY and KGO are the broadcasting stations of the General Electric Company at Schenectady and Oakland. Each, at times, is a concert hall, a lecture room, a news bureau, a theatre, or a place of worship.

GENERAL ELECTRIC

LIGHTING

The depressible beam automobile headlight is invented. It contains two filaments for "driving" and "passing" beams.

MATERIALS

A process for fusing quartz in pure form is developed by the Thomson Laboratory at Lynn. When bent, a fused quartz rod can allow light to turn corners, thus providing a useful tool for scientific and medical application.

MEDICAL EQUIPMENT

A portable electrocardiograph for studying the heart's electric currents is developed by H.B. Marvin of the General Engineering Laboratory.

COMMUNICATIONS

General Electric radio station KGO, located at Oakland, California, and sister station of WGY — Schenectady, is placed in regular operation, thus "bringing every corner of the Union within earshot of their messages and music."

The first rectifier tubes (UX-213) are developed for radio receivers to eliminate the need for high-voltage B batteries and thus supply this requirement from the AC line.

INDUSTRIAL EQUIPMENT

The largest hoist motor built to date is placed in operation. Rated at 2150 hp, 51 rpm, it is capable of lifting 5,000 tons of ore per 8-hour shoft from a depth of about 1/4 mile.

TRANSPORTATION

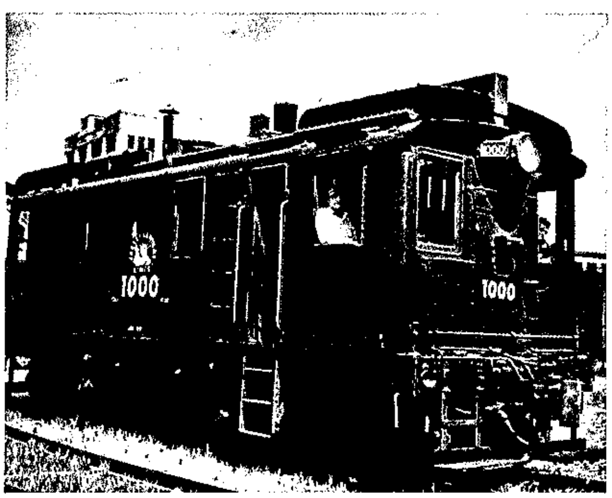
The first practical diesel-electric locomotive is demonstrated in New York City. It is a 60-ton, 300-hp unit, built by the American Locomotive Company using an Ingersoll-Rand diesel engine and General Electric generators and motors.

Frank W. Peek, Jr.

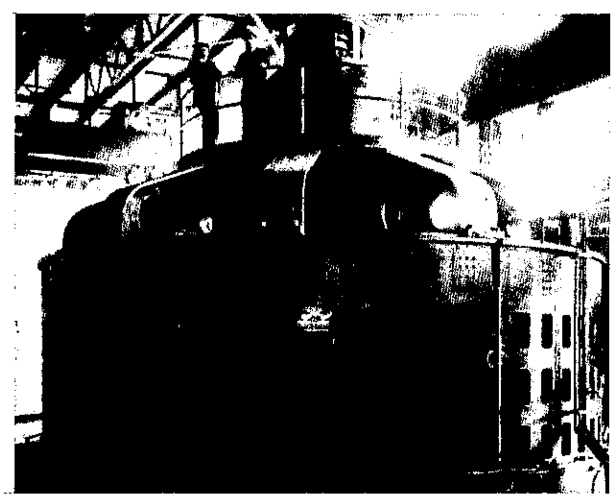
POWER GENERATION AND DISTRIBUTION

The Pittsfield Works High Voltage Engineering Laboratory headed by Frank W. Peek, Jr., uses a record 2,000,000 volt lightning generator to test apparatus designed for protection against lightning.

Two 65,000-kva, 12,000-volt waterwheel generators are installed for the Niagara Falls Power Company. They represent the maximum development in capacity and physical dimensions for this type of machine.



Nation's first diesel-electric locomotive, an Alco-GE unit.



65,500-kva generator for the Niagara Falls Power Company.

1925

Marvin Pipkin with inside-frost lamp.

Early thyratron tube developed by A.W. Hull.

LIGHTING

Inside frosting is adopted as a means of reducing glare and improving light distribution in standard light bulbs. An improved method of etching the bulb interiors, invented by Marvin Pipkin of the Nela Park Lamp Development Laboratory, produces lamps which are stronger and easier to keep clean than exterior frosted types.

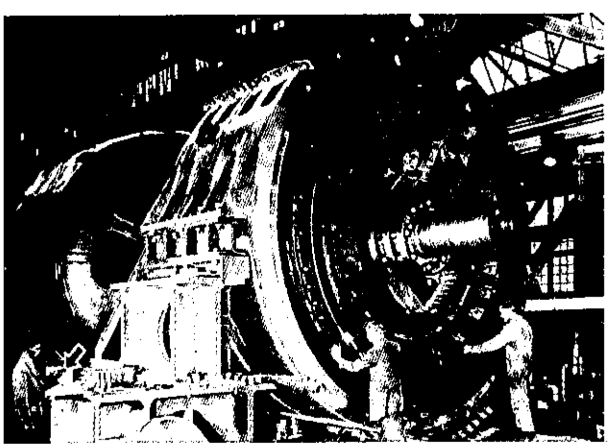
COMMUNICATIONS AND ELECTRONICS

Albert W. Hull dramatically improves the stability of vacuum tubes by the introduction of a screen grid tube, the tetrode. A similar tube was independently invented by Walter Schottky.

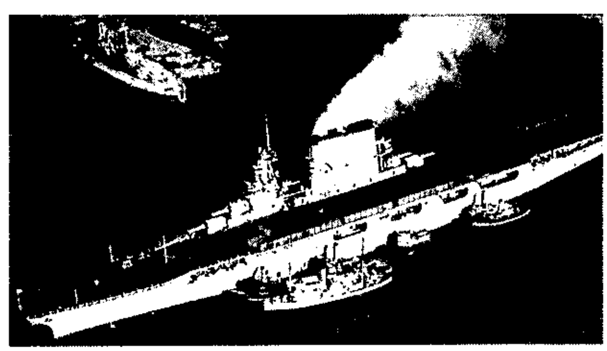
The Thyratron, a grid controlled mercury vapor rectifier, is developed by Hull and Irving Langmuir. The tube shows great promise of finding application in electronic control of medium power devices.

INDUSTRIAL EQUIPMENT

The world's largest steel mill motor is built. It is an 8000-hp, 240-rpm unit with higher continuous rating and operating voltage than any other induction motor in steel mill service.



World's largest motor, 22,500 hp, 220,000 lbs, for the "Saratoga"; World's smallest (Arrow), 1/4,000,000 hp, 4 oz.



Aircraft carrier U.S.S. "Saratoga."

TRANSPORTATION

Aircraft carriers U.S.S. "Saratoga" and U.S.S. "Lexington" are launched, each to be propelled by four 35,200-kw steam engine generators supplying power to eight 22,500-hp motor-driven propeller shafts. These 180,000-horsepower carriers are the largest naval vessels afloat.

A Canadian National Railway diesel-electric locomotive makes the longest non-stop run ever made by any engine — 2967 miles from Montreal to Vancouver in slightly under 67 hours, with a top speed of 60 mph. The controls and motors are supplied by Canadian General Electric, Ltd.

The Indianapolis 500 race is won by Peter DePaolo driving a Duesenberg Special with GE supercharger designed by Sanford A. Moss of Lynn's Thomson Laboratory.

MATERIALS

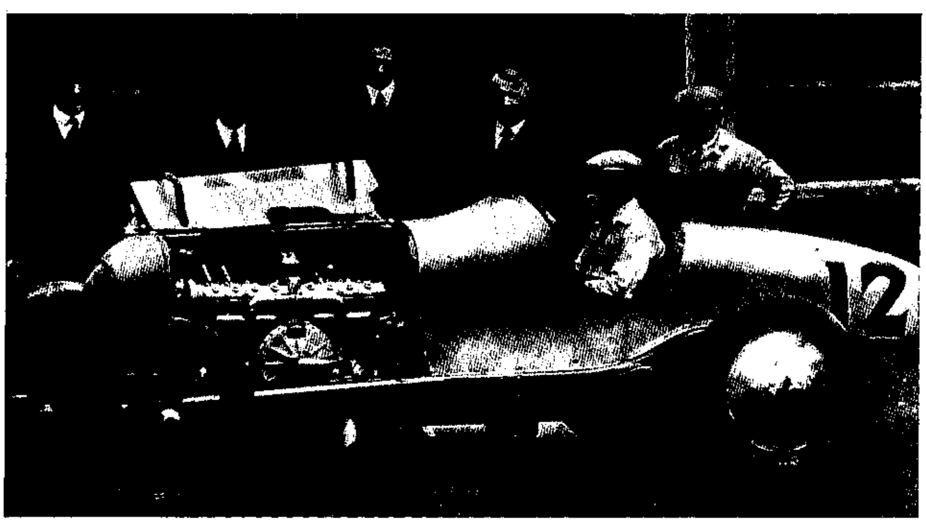
Thoriated tungsten filaments are developed for use in electron tubes. Work by Irving Langmuir at the Research Laboratory resulted in filaments from 8 to 50 times more efficient as producers of electrons than pure tungsten filaments.

"Glyptal" alkyd resins are introduced for paints, bonding laminates, lacquers, sealants and electrical insulation. Expanding on work started in 1912, Roy H. Kienle, J.G.E. Wright and others originated a number of reactions that could be used to produce Glyptals having properties specially tailored to the desired applications.

The first large-scale use of plastics for appliances is introduced when molded phenolic is used for the handle and thumb rest of flatirons. Pittsfield's John DeBell pioneers the large-scale application of phenolic for vacuum-tube bases.

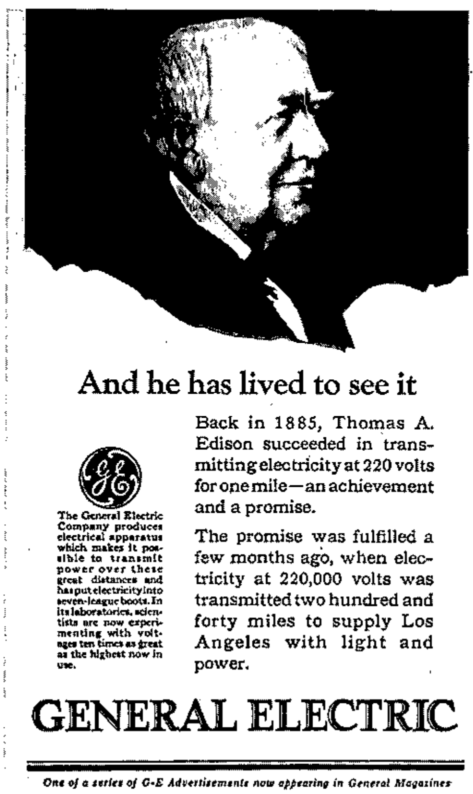
APPLIANCES

GE announces the first hermetically sealed domestic refrigerator. The development of this compact, quiet, low maintenance unit is the result of the combination of many technologies.



Indianapolis 500 winner with GE supercharger. (from left) Sanford Moss, August Duesenberg, R.W. Mercer, F.S. Duesenberg, James Kemp, and Peter DePaolo at the wheel.

1926



LIGHTING

The GE monogram and wattage and voltage ratings are etched on the ends of light bulbs, replacing paper stickers.

POWER GENERATION AND DISTRIBUTION

The world's largest single phase transformers, four 28,866-kva units, are built at the Pittsfield Works for the Pennsylvania Power and Light Company.

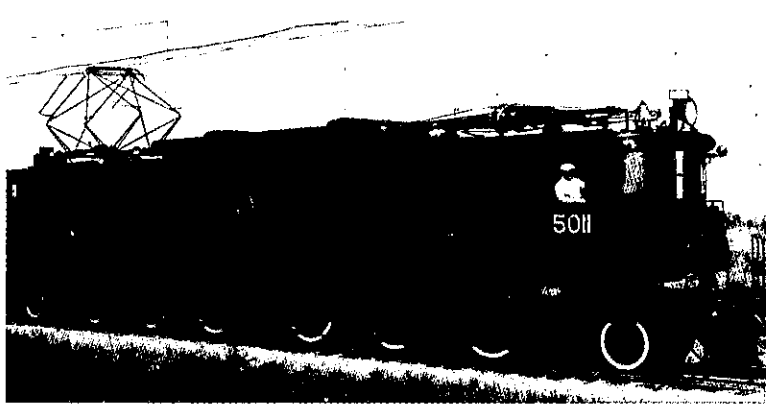
The highest voltage yet produced by man, 2,100,000 volts, is generated at Leland Stanford University with a six-unit GE transformer test set. This equipment, more powerful than any previously available, will permit the stringing and testing of full-sized transmission lines.

Three 50,000-kva synchronous condensers, the largest of their kind, are designed by GE engineers to regulate the voltage of the 220,000-volt transmission lines that carry power from the Big Creek hydroelectric development to the city of Los Angeles and vicinity.

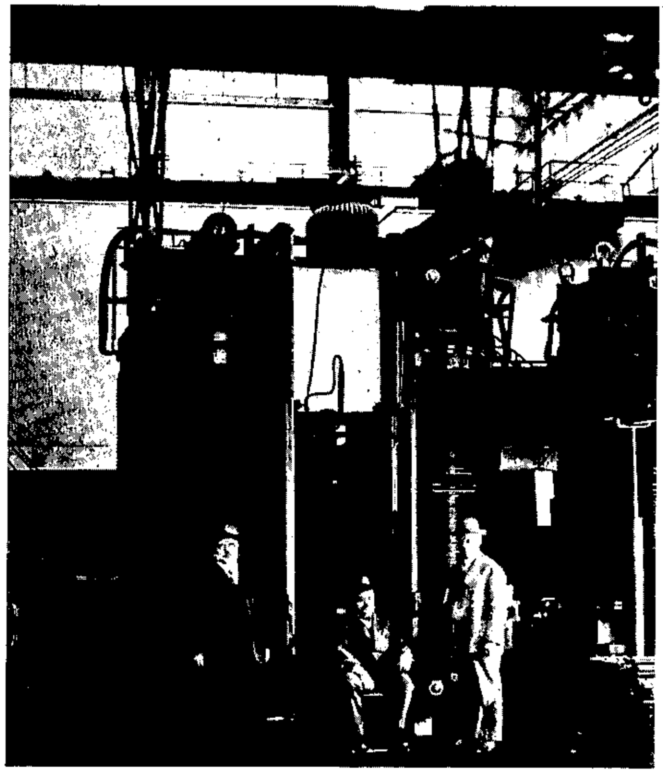
TRANSPORTATION

A combination storage battery, gasoline-electric locomotive hauls a passenger coach 450 miles from the Erie Works to Chicago. Capable of using either energy source or a combination of the two, the electric locomotive can operate without an overhead trolley or third rail.

The most powerful single-unit motor-generator locomotives yet, 3300-hp, 270-ton units, are being built for use in the Great Northern Railroad's new 8-mile-long tunnel through the Cascade Mountains.



Single-unit, motor-generator locomotive for the Great Northern.



Record size 28,866-kva transformer being built at Pittsfield. In foreground (r. to l.) transformer pioneers, C.C. Chesney, G. Faccioli and W.S. Moody.

INDUSTRIAL EQUIPMENT

The first all-electric car dumper for loading coal into ships goes into operation at Toledo, Ohio, with General Electric equipment. Great Lakes coal transportation can now be significantly faster as these units replace older steam-driven dumpers.

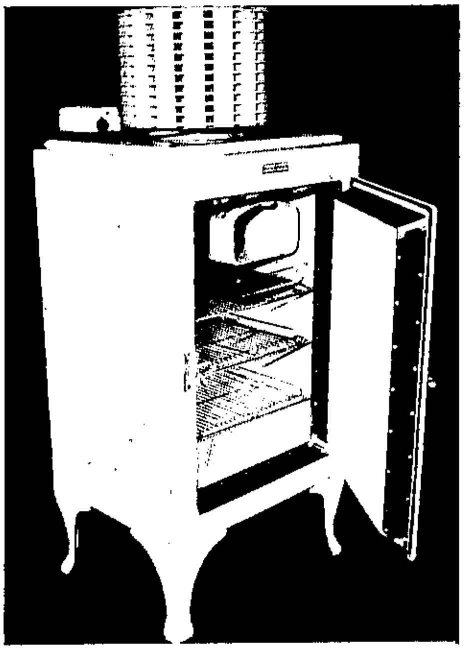
COMMUNICATIONS AND ELECTRONICS

Charles A. Hoxie of the General Engineering Laboratory receives a patent for a method of recording sound on photographic film. The equipment for talking movies, which he called the "Pallo-Photophone," was first demonstrated in 1921.

Chester W. Rice and Edward W. Kellogg develop the dynamic loudspeaker to replace the horn arrangement currently used for group listening to radio broadcasts. The sound reproduction is excellent and virtually devoid of distortion. A magnetic phonograph pickup is also developed to improve the fidelity of recorded sound.

E.W. Kellogg working with new dynamic loudspeaker.

1927



The Monitor Top refrigerator.

INDUSTRIAL EQUIPMENT

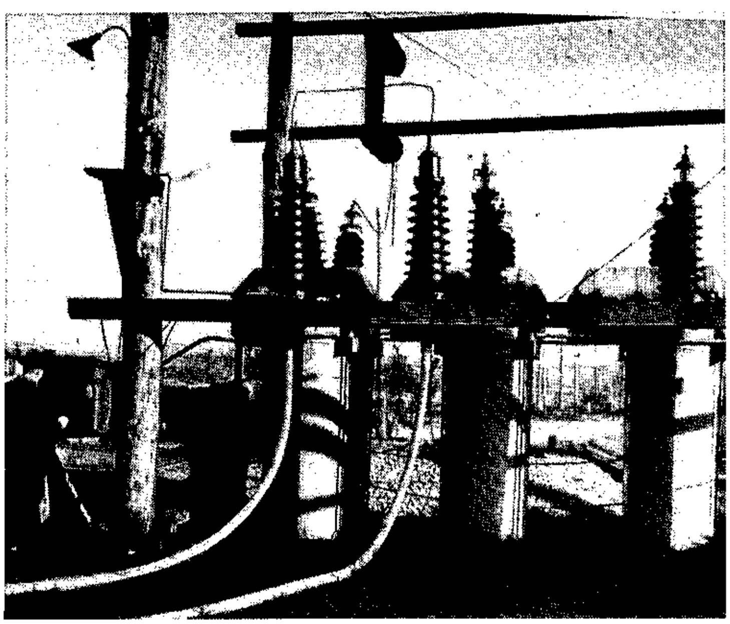
A mercury vapor detector for improved plant safety is developed by B.W. Nordlander.

APPLIANCES

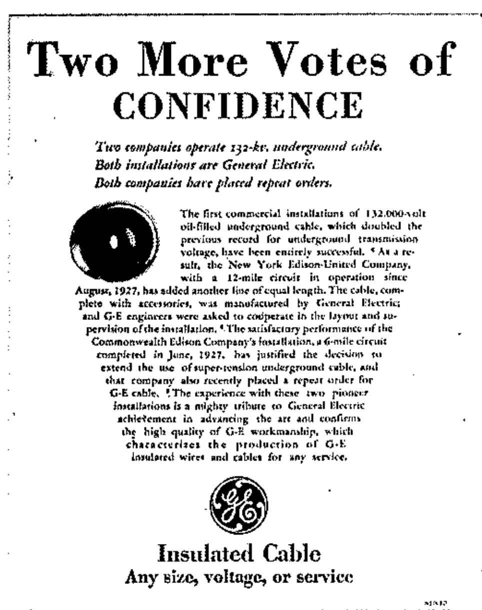
The Electric Refrigeration Department is established and begins production of the "Monitor Top" hermetically sealed refrigerator. Its all-steel cabinet is another GE innovation.

POWER DISTRIBUTION

Underground single-conductor oil-filled cables capable of carrying 132,000 volts are successfully put in service in a six-mile line by the Commonwealth Edison Company of Chicago and a twelve-mile line by the New York Edison-United Companies.



Underground cable installation



COMMUNICATIONS AND ELECTRONICS

Transmitting equipment rated at 100 kw is successfully used by GE Station WGY — Schenectady. Only a few years past, station powers were half-kilowatt power. Now several stations are transmitting with 50 kw.

The first home television reception takes place at the Schenectady, N.Y., residence of E.F.W. Alexanderson.

E.E. Burger develops the first General Electric Cathode Ray Oscilloscope.

TRANSPORTATION

The S.S. "California" is launched — the first large passenger ship with turbo-electric drive. With a cruising radius of 15,400 miles and speed of 18 knots, she is the largest electrically driven ship of her class in the world. The Marine and Aircraft Department is established.

ORGANIZATION

The Gerard Swope Load Fund is established to provide educational opportunities for employees and their children, and the Educational Loan Fund is established to supplement it.

First home television reception at Schenectady residence of Ernst F.W. Alexanderson.

100 kw transmitting equipment at station WGY.

Chris Steenstrup
1873-1955

Christian Steenstrup

"Father" of the Monitor Top Refrigerator

An American home today without an electric refrigerator is a rarity, but in the early 1920's only a few thousand homes in this country had refrigerators, and nearly one half did not have an icebox. Christian "Chris" Steenstrup changed all that when he took an idea conceived by a French monk, Marcel Audiffren, and championed by Ft. Wayne's James T. Wood, and adapted it for mass production and consumer acceptance. Prior to Steenstrup's invention, refrigerators produced by General Electric at Ft. Wayne under contract to the American Audiffren Co. of N.Y. sold for as much as $1,000, twice the cost of an automobile.

Before accepting an offer from General Motors to obtain the rights to this technology, the Company conducted a study under the leadership of Alexander Stevenson. It concluded that a significant market for refrigerators existed, and that they could be produced at a lower cost with high reliability. Designers throughout the Company were requested to submit their ideas. The most promising concepts came from Clark Orr of the Fort Wayne Works and from Chris Steenstrup of the Schenectady Works. Late in 1925, Steenstrup's design was selected for development. It was not long before the success of that design was to earn for him the title, "father of the 'Monitor Top' " refrigerator, one of GE's most successful products.

Born in Aarhas, Denmark, Steenstrup migrated to America in 1894, joining a friend in Bridgeport, Connecticut, to work for a large company manufacturing artillery and ammunition. He had been trained as an apprentice in a machine shop for three years and as a journeyman for two years. While working, he attended night school to acquire a technical education.

In 1901, following a strike at the ammunition company, he sought employment elsewhere to support his family. He came to Schenectady General Electric one day with some friends and found a crowd of men waiting at the gate for employment. A man with a bullhorn asked if there were any mechanics in the crowd and Chris presented himself. He was hired immediately as a mechanic's helper. It was not long before his inventive genius became apparent. He developed a method of hydrogen brazing which became a manufacturing process widely used in the production of reliable, leak-free connections. The invention won him the Company's prestigious Charles A. Coffin Award.

He served as Supervisor of Mechanical Research and was responsible for the design and development of a variety of equipment used throughout the Schenectady Plant. He became involved in several large turbine construction projects and made contributions that added to the efficiency of these units.

Chris rose to the position of Chief Engineer of the Electric Refrigeration Department which was organized in 1927, after his work led to the design of the first successful hermetically sealed refrigerator. The original patent on the refrigerating machine was filed on November 13, 1926 and granted on April 15, 1930. Thirty-nine additional patents in refrigeration followed that initial work. In 1936, at the Centennial celebration of the American patent system, he was identified as one of the 20 living Americans awarded 100 patents since the founding of the system.

Under Steenstrup's guidance, a relatively small but highly trained group of Factory Contact Engineers and a quality conscious factory organization steadily raised the quality level of electric refrigerators until a degree of perfection was attained that had probably never been experienced with a manufactured article of such complexity.

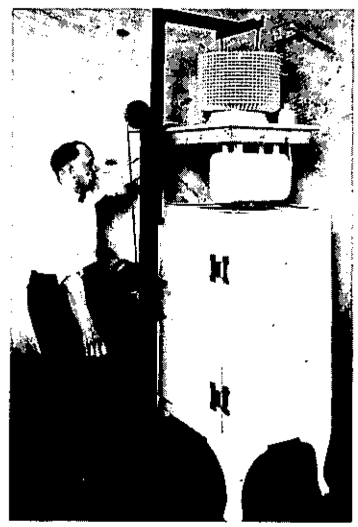
From the very first day of his employment at GE, Steenstrup never hesitated to interject an idea when he thought it could help a colleague or the Company. In 1949, he was honored by the National Association of Suggestion Systems for his pioneer work in 1906 leading to the development of a suggestion system that has since brought many benefits to the Company and its employees, and has served as a prototype for industry.

The Birth of the Monitor Top Refrigerator

Clark Orr
Ft. Wayne designer of some of GE's earliest refrigerators

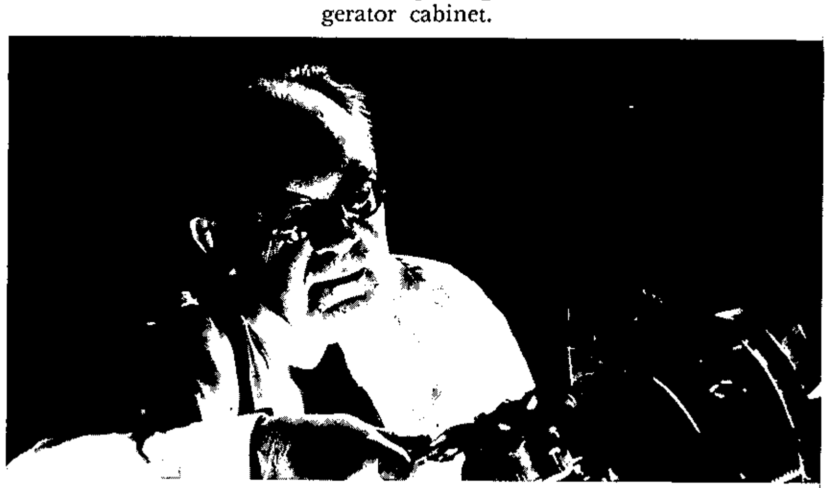
Abbe Marcel Audiffren, inventor of the first electric refrigerator. Second from left is A. Singrun, French manufacturer. A. Myers, left, and James J. Wood, right, who arranged for GE to build the Audiffren machine at Ft. Wayne, Ind.

Alexander Stevenson whose recommendations placed GE firmly in the refrigeration business.



Lowering icing unit into refrigerator cabinet.

Wilbur L. Merrill, head of the Schenectady Works Laboratory, developed the double wall steel cabinet for the Monitor Top Refrigerator.



Steenstrup inspecting refrigerating machine mechanism set up in lathe.

1928

World's largest electric shovel, 15 cu. yd.

Samuel Hoyt with Carboloy tools and machined samples.

LIGHTING

The most powerful lamps to date, rated at 50 kw, are introduced for airport and other high intensity lighting applications.

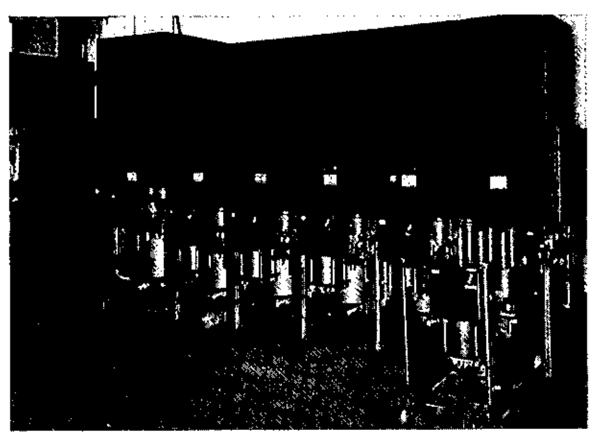
INDUSTRIAL EQUIPMENT

The world's largest electric shovel, a 15-cu.-yd. unit, goes into operation in the coal mining industry, using GE motors and controls.

POWER GENERATION AND DISTRIBUTION

The first hydrogen-cooled machine to be placed in commercial service is a 12,500-kva synchronous condenser, manufactured by GE and installed at the New England Power Company's Pawtucket, Rhode Island, station. Experiments leading to its construction were performed by Chester Rice in response to a suggestion by Willis R. Whitney, head of the Research Laboratory. The use of hydrogen in place of air reduces friction and heat losses, thus permitting increased capacity for a machine of given size.

Hydrogen cooled synchronous condenser at Pawtucket substation of New England Power Association.



Metal-clad switchgear for the City of Los Angeles.

"Metal clad" switchgear is introduced by GE for outdoor switching stations. The total enclosure of every current-carrying part not only gives protection to operators and maintenance men but prevents secondary breakdowns that may occur in open-type switching equipment. The Switchboard Department is changed to the Switchgear Department.

MATERIALS

"Carboloy," a GE registered trade name given to extra hard alloys made of tungsten carbide and cobalt, is perfected at the Research Laboratory by a team including Samuel L. Hoyt, Floyd Kelley and Emory G. Gilson. The new material is harder and tougher than the best high speed steels, making it excellent for use in cutting tools, drill bits and dies. The Carboloy Company is organized to produce and market the new material.

TRANSPORTATION

The first single unit diesel-electric freight locomotive, rated at 750 hp, is in service on the New York Central, providing economical as well as clean service.

COMMUNICATIONS

WGY initiates the broadcasting of television programs twice weekly. One of these is the first play ever presented on television, "The Queen's Messenger." On August 22 Governor Al Smith is televised as he accepts the nomination as presidential candidate of the Democratic Party. This marks the first use of a portable television transmitter as an outside pick-up for a news event.

E.F.W. Alexanderson devises a method of calculating the altitude of a plane by directing a radio beam downward and picking up its reflection. A radio altimeter based on this principle is under development and will enable pilots to determine their altitude in all kinds of weather, making air travel safer.

Preparing for the world's first television play, "The Queen's Messenger" at GE station WGY.

AROUND THE WORLD WITH GENERAL ELECTRIC

Japan

When Tokyo recently opened its new subway, the very first subway in the Orient, the gates were crowded from 6 o'clock in the morning until 12:30 the next morning, when they were closed. Many people stayed around just for the thrill of riding underground for the first time. The turnstiles were furnished through the Tokyo office of the I.G.E. and the cars were run by G-E motors.

Bolivia

Above the clouds in the mountains of South America, at an elevation of 14,000 feet, the Ratio Mines and Enterprises Co. of Bolivia will install 23 switchboard panels. This board which is being built at the Philadelphia Works, will control 10,000-volt incoming line and transformer banks, 3000-volt synchronous motors and 220-volt lighting, small motor, and generator circuits.

India

The selling field of wire and cable is highly competitive. Many firms manufacture it. It is difficult to create an outstanding product. However, the Mysore Government has ordered G-E cable for ten miles of underground service. This is probably a reflection of its confidence in the material and workmanship of G-E products, as similar cable has been furnished by us to this native government before.

1928

INTERNATIONAL GENERAL ELECTRIC COMPANY INC.

Electricity has a mission—to bring more comforts into the daily lives of more people

Russia

The International General Electric Company and the Amtorg Trading Corporation, of New York, announced recently that they had signed, under date of October 9th, a contract covering the supply of electric apparatus for export to the Union of Soviet Socialist Republics (Russia).

The contract provides for the purchase on the part of the Amtorg Corporation of not less than $5,000,000 or more than $10,000,000 worth of apparatus and material during the first two years.

England

Following the successful application of turbine-electric drive to approximately 40 American ships, the British have taken up the cue. A 19,000-ton passenger liner, using this means of propulsion, is being built in England for the Peninsula and Oriental Navigation Company, one of the oldest ship-operating companies in the world. This ship, 600 feet long, will be the first large electrically-driven vessel built in Europe. It will operate between ports in England, India and Australia.

Brazil

An order for $100,000 worth of light was received from Brazil recently. This includes 774 General Electric novalux lighting units, and about 500 standards on which they will be mounted. In addition, the necessary cable, insulators, and other G-E material needed for this installation will be supplied. This is one of the largest orders ever received by the International General Electric. This order not only brings us more work, but shows that G-E products, because of their high quality and the excellent service they give, are gaining steadily in popularity.

Chile

The Chile Exploration Company bought six 70-ton G-E electric locomotives about a year ago, and recently turned in a repeat order for three more. This has made necessary an extension of substation capacity. So the order includes a G-E mercury arc rectifier together with the necessary transformers, switching equipment and an ample supply of spare parts. This apparatus will be installed at an elevation of 9500 feet above sea level.

Canada

In order to transmit power from the new Gatineau Power Company's generating station at Paugan Falls to Toronto, a distance of 250 miles, it has been necessary to use the highest transmission voltage ever used in Canada, 110,000 volts. Twelve transformers for operation at 220,000 volts were supplied by the Canadian General Electric Co., Ltd. Nine of these will step the generator voltage up from 6600 to 220,000 volts, and the remaining three will be used to supply power to the 110,000-volt transmission system.

France

In spite of high import duties and shipping costs, G-E equipped products are being shipped in ever greater quantities abroad. This alone is a high compliment to the quality of our products and would seem to indicate that they are more highly efficient and economical than those of our European competitors. A whole carload of washing machines and ironers, all fitted with G-E equipment, was recently shipped from Chicago to the French Thomson-Houston Co.

EXTRACTS FROM FT. WAYNE WORKS NEWS — 1928

RELIVING THE EDISON ERA

Henry Ford's intense admiration for the genius of Thomas Edison made him one of the chief supporters of Light's Golden Jubilee, the 50th anniversary of the invention of the incandescent lamp.

"Light's Golden Jubilee," said Mr. Ford, "is conceived and planned as a celebration of electrical progress in the last 50 years as it is typified by the improvement and universal acceptance of the incandescent lamp from its invention in 1879. But it is not that alone. I believe Mr. Edison would agree with me that the celebration should be taken, not as glorifying what has been done in the past 50 years, but as indicating what will be done in the next ten. I say ten years, because in that period we shall see an advance as great as that made in the past 50 years. The world is just getting its momentum. Ideas accomplish themselves much more rapidly than they did even 25 years ago.

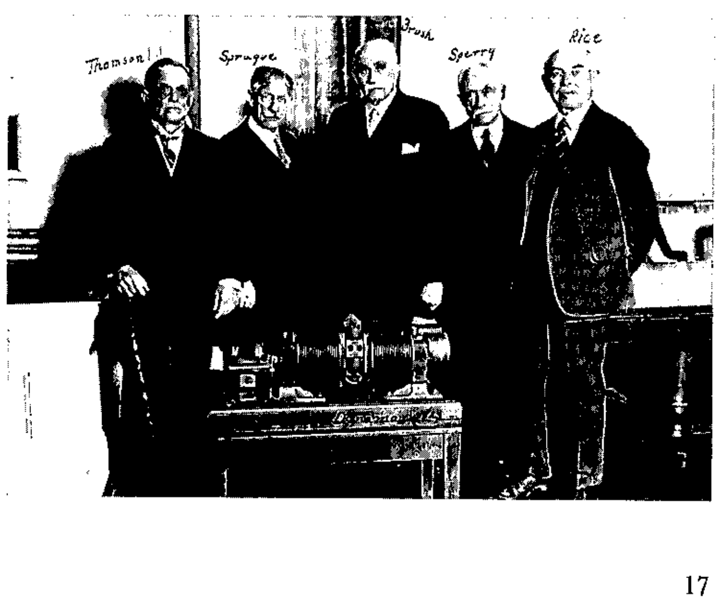
The use of electricity is yet little to what it will be in the next ten years. Power is the center of industry. It is assuming an indispensable place in agricultural and domestic life. We have not yet fully realized that the function of the workman is to direct power, not to exert it. We are closer to that realization in industry than in agriculture or in housekeeping. Having the energy of electricity to do our bidding, there is no reason for human backs to strain, for arms to lift nor legs to stagger under heavy loads."

Electrical World, 1929

Celebrating the Golden Jubilee of the Incandescent Lamp

Thomas Edison recreates his invention of the incandescent lamp as Henry Ford (center) and former Edison assistant Francis Jehl look on.

Location: a replica of Edison's Menlo Park laboratory, built at the Henry Ford Museum, Dearborn, Mich.



Meeting of Electrical Pioneers at Franklin Institute, celebrating the Golden Jubilee of the Brush Dynamo. From left to right: Elihu Thomson, Frank Sprague, Charles F. Brush, E. Sperry, and Edwin W. Rice, Jr.

1929

"Palm Beach in Brooklyn" with the aid of GE sunlamps at the swimming pool of the Hotel St. George.

Drum Cartridge facsimile transmitted from Station KGO, Oakland, to Schenectady's General Engineering Laboratory.

LIGHTING

The S-1 mercury vapor sunlamp is introduced. It is the first lamp bulb generating ultraviolet rays for the purpose of suntanning without danger of damage to the eyes.

APPLIANCES

The "Handy" hand-held electric vacuum cleaner is announced. A new iron is marketed with a "button nook" to facilitate ironing around buttons.

TRANSPORTATION

The aircraft carrier U.S.S. "Lexington" breaks all existing records for a capital naval ship in its California-to-Honolulu run, averaging 30.7 knots for 72 hours. She produces 31% more power than the largest naval vessel heretofore built.

COMMUNICATIONS AND ELECTRONICS

Radio-photos are received regularly by the General Engineering Laboratory at Schenectady from Radio Station KGO, Oakland, California. Drum cartridge facsimile photographs of Colleen Moore, Norma Talmadge, Douglas Fairbanks and Mary Pickford are favorites for transmission. A time of 2-1/2 minutes is required to broadcast a single photograph.

ORGANIZATION

The General Electric Supply Corporation is formed with headquarters at Bridgeport, Conn. C.E. Patterson is selected as president and director.

POWER GENERATION AND DISTRIBUTION

The largest electrical generation unit in the world is installed by General Electric engineers at the Commonwealth Edison Company's State Line Power Station in Hammond, Indiana. The 208,000-kw, three-unit steam turbine-generator has a capacity four times that of most units in service.

Four 77,500-kva vertical shaft waterwheel generators are under construction for the Dnieper River Development in Russia. With an overall diameter of approximately 40 feet, they exceed in physical dimensions as well as electrical capacity any waterwheel generators previously constructed.

The world's largest single shaft steam turbine-generator, 160,000 kw, is installed at the East River Station of the New York Edison Co.

The Pittsfield High Voltage Laboratory announces the production of 5,000,000-volt artificial lightning, and GE radio station WGY broadcasts the event.

Charles E. Eveleth

Waterwheel generator room of Dnieper River Station, Russia.

Three-unit, 208,000-kw turbine generator at State Line Power Station, Hammond, Indiana.

PIONEERING BIGGER AND BETTER

Oscar Junggren
1865-1935

When built in 1902-1903, the Curtis-Emmet turbine ordered by Samuel Insull for the Chicago Edison Co. was the largest of its kind in the world, and, with a rating of 5000 kilowatts, was just ten times more powerful than any of its predecessors. During design work on this previously unheard-of titan of power generation, there were many who said "It cannot be done." Oscar Junggren helped prove them wrong.

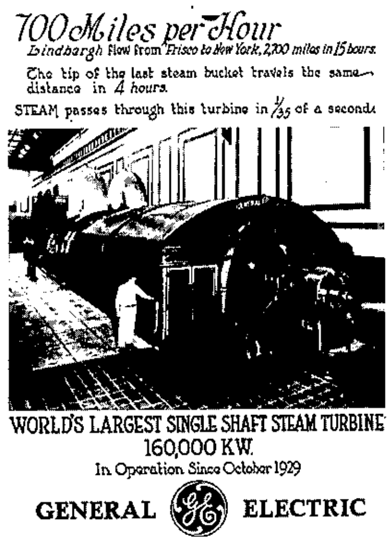
He collaborated with Chief Engineer W.L.R. Emmet in the design and construction of a machine that clearly demonstrated the superiority of the steam turbine and set the stage for its widespread use. That historic machine is now displayed in the Schenectady Works as a "Monument to Courage."

Born in Landskrono, Sweden, Junggren attended the engineering college of Malmo in that country, graduating in 1885 from the mechanical engineering course.

After coming to the United States, he was first employed by the Edison General Electric Company in New York City in 1889 and later transferred to Schenectady where he became involved in the design of steam power equipment. In 1902, he was appointed design engineer of the Turbine Department, continuing in this capacity until 1922, when, in recognition of his outstanding design ability, he was made consulting engineer of that department.

From then until he became ill in 1934, he worked with Glenn Warren and others in the conception of a number of unique designs that resulted in ever increasing operating efficiency and reliability. In 1931 he received a Charles A. Coffin Award, having been cited for his work as "a creator and designer of large turbine units and particularly for his invention of the steeple-compound turbine." That was indeed a conservative description of a man who was one of the giants of the turbine industry.

Oscar Junggren



Generator installation at East River Station of the New York Edison Company.

A Tribute

If it was Archimedes who said "Give me a place to rest my lever and I will move the world," that pioneer physicist and mathematician would have been astounded to hear that, in Schenectady, New York, in a land outside his ken, 2147 years after his death, there would be a man whose genius would be credited with energizing one-half the world, not in theory, but in fact.

For it is said by even the unimaginative engineers that fully one-half the electric power developed in the world today is produced by means of turbines designed by the fertile brain of Oscar Junggren, so modest a man that few of us even recognized him as he went back and forth through our streets for four and forty years.

The production of kilowatt-hours has been said to be the big industry of Schenectady. It is such a tremendous undertaking to devise machines which will produce economically the harnessed thunderbolts of Jove that move half the world that, when the designing brain that put forth these machines is stilled in its earthly activities, it is an event which is of importance far beyond the ordinary range of human affairs.

None but technical people can grasp the immensity of this genius' labors who, in the eight years from 1924 to 1932, produced 30 turbines, each of an entirely new design; but the most nontechnical of us can recognize the amazing productive power of that prolific mind, and the man's unremitting industry in giving form to these new ideas which move half the world.

This is the substance from which the fame of Schenectady is built. The city has every reason to honor such genius.

—Schenectady Union-Star, 1935

STEAM TURBINES

Glenn B. Warren
1898-1979

Engineer and distinguished businessman, Glenn Warren was associated with the General Electric turbine business during a period when approximately 96 million kilowatts of steam turbine-generators for electrical power generation were produced in Schenectady and Lynn for electrical utility and industrial applications around the world. Much of this output and the growth of an entirely new industry for the application of gas turbines to electrical production were due, in no small measure, to his contributions.

Glenn B. Warren holds smallest GE turbine wheel (6-in. diameter, 34,000 rpm, for supercharger). In background is portion of largest (14 ft. diameter, 1800 rpm, for steam turbine) wheel.

Born in Western Missouri in 1898, Warren grew up in neighboring eastern Kansas and was graduated from the University of Wisconsin with a B.S. degree in 1919 and an M.E. in 1924. His thesis on gas turbines was supported by extensive experiments.

Warren joined General Electric in 1919 as a member of the Test Engineering Program. Shortly thereafter he received a letter indicating that he had been nominated for a Rhodes Scholarship. As a result, he talked with Charles Eveleth, Executive Engineer of the Turbine Department, who asked Warren what he really wanted to do. Warren replied, "I guess I want your job eventually." "O.K., we'll take you on in the Turbine Department for three months. If you don't like it after that, you can quit," was Eveleth's response. Warren accepted and stayed on to receive worldwide recognition as a skilled turbine engineer and eventually became Vice-President and General Manager of the Turbine Division.

After joining the Turbine Department, he proposed that work be started on gas turbines in Schenectady. This was delayed for a number of years as Warren said, "We didn't have the materials technology at that point in time." Instead he undertook an extensive research program to improve the efficiency of steam turbines which had over a period of five years exhibited less than expected efficiencies. Experiments with W.E. Blowney and H.L. Wirt on wood and metal models of the steam passages enabled fundamental laws of turbine design to be established which are the basis of present day GE turbine designs.

General Electric's 208,000-kw unit at the Commonwealth Edison Company's State Line Power Station, now an ASME National Historic Mechanical Engineering Landmark, was a major development in turbine technology under Warren's direction. Placed in service in 1929, this unit's capacity was four times greater than most units then in service and remained the largest generating unit in the world for 25 years. It was still in daily operation in 1978.

Warren directed the design activities in the mid-thirties that led to the now worldwide standard type of turbine design employing a double shell construction.

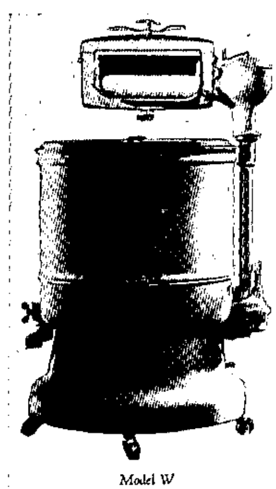
During World War II, he and Alan Howard led a Schenectady-based Turbine Department team involved in the development of GE gas turbines for aircraft jet and propeller propulsion.

Warren's honors during his career were numerous. For his excellence in engineering and advancement of turbine-generator technology, he was awarded an honorary Doctor of Science degree by Union College. Other career honors included the ASME Gold Medal and Honorary Life Membership; the John Fritz Gold Medal, presented by four engineering societies; the David W. Taylor Gold Medal, SNAME; and the Newcomen Gold Medal for Steam Power.

1930

First photoflash lamp.

Karl B. McEachron



GE electric clothes washer.

LIGHTING

A new era in photography is begun in the United States as Photoflash lamps are introduced to replace the cumbersome and dangerous, open pan, flash powder ignition light sources. The sealed bulbs produce a brilliant flash of white light timed to a fraction of a second and able to be synchronized with the camera shutter.

MATERIALS

The Plastics Department is formed to implement developments in plastics beyond the company's needs for insulation materials.

The "Thyrite" lightning arrester is developed by Karl B. McEachron of the Pittsfield High Voltage Laboratory. Thyrite, a densely fired material made principally of silicon carbide bonded with a class of clay, has the unique property of being an insulator for ordinary high voltages, but becomes a conductor to ground for extra-high voltages and surges produced by lightning, thus protecting transmission lines.

APPLIANCES

The first commercial line of electric clocks is introduced by GE affiliate, Warren Telechron Co. In 1917, Henry E. Warren invented an electric clock which would operate on household alternating current. Telechron clocks were first used as master clocks for frequency regulation in electric utilities.

The Calrod® high speed heating unit is incorporated in home electric ranges by the Hotpoint Company. An electric clothes washer for home use is placed on the market.

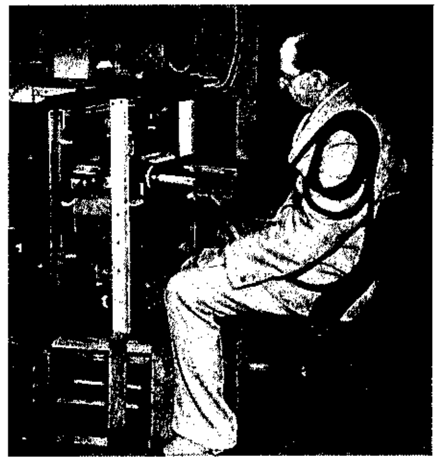
INDUSTRIAL EQUIPMENT

A new line of totally enclosed, fan-cooled induction motors, rated at 3/4 hp to 30 hp, is introduced. The units have the same mounting dimensions as the open-type motors but are fully protected for operation in dust and other potentially damaging environments.

MEDICAL EQUIPMENT

The General Electric X-Ray Corporation is the new name given to GE's affiliate, the Victor X-Ray Corporation. Ten years earlier, Victor had begun distribution of GE X-ray equipment stemming from developments pioneered by William D. Coolidge.

Willis R. Whitney invents the "artificial fever" machine for use of high frequency waves in the treatment of certain illnesses. The machine, known as the "inductotherm" or "radiotherm," is manufactured by the X-Ray Corporation. Experiments also indicate its potential for the cooking of food and industrial heating.



Willis R. Whitney and "artificial fever" machine.

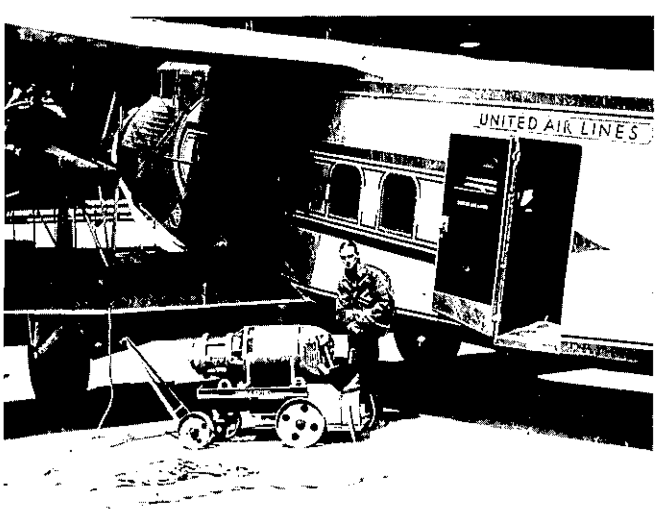
COMMUNICATIONS AND ELECTRONICS

E.F.W. Alexanderson demonstrates projection television in Proctor's Theatre, Schenectady, with images on a 7-foot screen. GE radio station WGY increases its radiated power to 200 kw.

TRANSPORTATION

The motor-driven magneto compass turn compensator is designed, correcting the turning errors previously experienced on compasses. Accurate indication of direction, even in steeply banked airplane turns, is now possible.

GE welding equipment is utilized in the construction of the "Carolinian," the first all-welded steel cargo vessel built in America, reducing both manufacturing time and maintenance requirements. Similar welding equipment is being manufactured for airplane fabrication.



GE welding equipment used by Boeing Airplane Company to build transports for United Air Lines.

PIONEERING IN COMMUNICATIONS

Ernst F.W. Alexanderson
1878-1975


Young Alexanderson on GE "Test".

On Christmas Eve, 1906, the world's first voice radio broadcast passed into history. Behind that event stood a young General Electric engineer, Ernst Frederick Werner Alexanderson, who had spent the previous two years designing and constructing the high-frequency alternator that made the broadcast possible. That achievement, which gave the U.S. its start in the field of radio communication, was to prove but one of many during Alexanderson's career. During his 46 years with GE, he was to receive 322 patents.

Ernst F.W. Alexanderson was born on January 25, 1878, at Uppsala, Sweden. The young man developed an early interest in electrical engineering that was stimulated by a year of technical work at the University of Lund in 1896. He then spent three years at the Royal Institute of Technology in Stockholm, from which he was graduated in 1900 as an electrical-mechanical engineer. Upon reading a copy of "Alternating Current Phenomena," by Charles P. Steinmetz — GE's mathematical giant, he was so impressed that he decided to move to America to seek work with the author.

In 1901, Alexanderson visited Steinmetz in Schenectady and in 1902, on the latter's recommendation, GE gave him a drafting job. The following year, he took GE's Test Engineering Course, and in 1904 he became a member of the engineeing staff designing generators under the direction of Steinmetz.

When Steinmetz organized a Consulting Engineering Department in 1910, Alexanderson became a member of the group. In 1915, Guglielmo Marconi arranged to have a 50-kilowatt Alexanderson alternator installed in his transatlantic Marconi Company station in New Brunswick, N.J.

During World War I, Alexanderson perfected a 200-kilowatt alternator which was installed at the same station. It was used by President Woodrow Wilson in transmitting messages to the war theatres of Europe and, on October 20, 1918, transmitted Wilson's ultimatum to Germany, which brought the war to a close.

In 1918, Alexanderson became head of GE's newly organized Radio Engineering Department. The next year, when Marconi bid for exclusive rights to the alternator, President Wilson appealed to GE not to sell and instead to help organize an American company that would use it. This led to the formation of the Radio Corporation of America, with Alexanderson becoming its chief engineer in 1919.

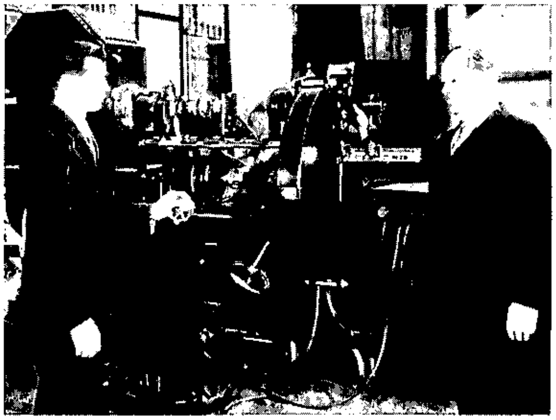
Meanwhile, Alexanderson's inventive genius had been hard at work. Among his notable radio developments were the magnetic amplifier, the electronic amplifier, the multiple tuned antenna, the antistatic receiving antenna, and the directional transmitting antenna. He also devised radio altimeters, and his studies in the polarization of radio waves made possible effective radio direction finders.

Alexanderson himself made the magnetic amplifier obsolete with his invention of the electronic amplifier. This was essentially the application to radio telephony of the vacuum tube improvements worked out by Irving Langmuir of the GE Research Laboratory. These tubes became the basis for all present-day radio broadcasting.

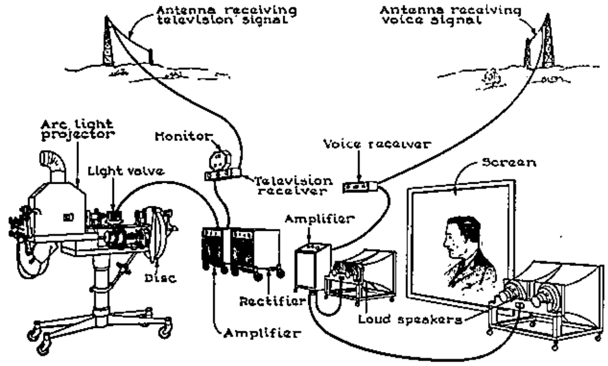
From 1919 to 1924, he divided his time between General Electric and the Radio Corporation of America, maintaining his residence and laboratory in Schenectady but personally superintending construction of powerful radio stations around the world.

In the next few years, Alexanderson performed pioneering work in television and the transmission of pictures by radio. With equipment employing a perforated scanning disk and high-frequency neon lamps, he staged the first home and theater demonstrations in 1927 and in 1930, in Schenectady.

AND ELECTRONICS



Television projector designed by E.F.W. Alexanderson and demonstrated at Schenectady's Proctor's Theatre.



A Diagram of the Entire Television Receiving Apparatus

Alexanderson's experiments with picture transmission from San Francisco to Schenectady forecast the regular radio transmission of pictures and facsimile broadcasting. On June 5, 1924, he had sent over the Radio Corporation of America's stations the first transatlantic facsimile. It was a handwritten greeting to his father in Sweden.

With GE's withdrawal from the affairs of the Radio Corporation of America in 1933, Alexanderson devoted himself at GE to the power applications of electronics, such as power transmission with direct current. In 1935, GE installed a direct-current power-transmission system using the mercury arc inverter which he had invented more than a decade earlier.

The GE inventor's laboratory also produced the amplidyne, an extremely sensitive and powerful system for amplification and automatic control that was successfully applied in steel mills and other places requiring delicate control of continuous operations. The principle of the mercury arc inverter used in DC power transmission found another application in the development of a variable-speed AC motor known as the thyratron motor.

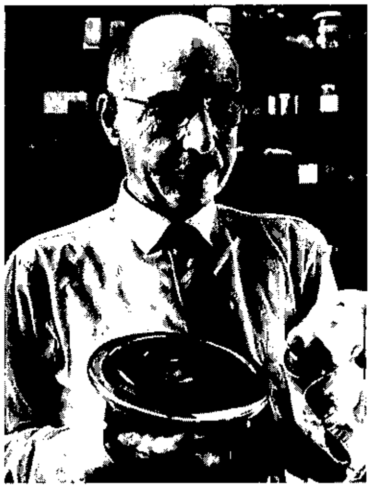
Alexanderson never wavered in his interest in shortwave phenomena and in television. In 1939, GE engineers in the Helderberg Hills near Schenectady regularly began to receive high-definition television from New York, 129 miles away. In 1940, the first television relay station operating at such a distance began to rebroadcast New York programs.

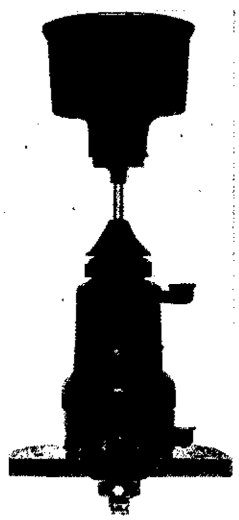
With the broadening scope of its activities, Alexanderson's Radio Consulting Department had become the Consulting Engineering Department in 1928 and finally the Consulting Engineering Laboratory in 1933. In 1945, this organization was merged with GE's General Engineering Laboratory to form the General Engineering and Consulting Laboratory. Alexanderson served as a consulting engineer on the staff of the new organization until his retirement in 1948, then continued as a consultant for another year.

The awards and honors that came to Ernst F.W. Alexanderson are too numerous to list here, but one need not look too far to see the working monuments which embody the results of his pioneering efforts in communications and electronics.

Alexanderson and A.H. Mittag with part of thyratron motor control equipment.

1931


Louis Navias, "Mr. Ceramics" of General Electric.


Vertical-mount motor for rayon spinning.


Everett S. Lee

LIGHTING

Albert W. Hull of the Research Laboratory receives a patent on a low pressure mercury-vapor lamp.

MATERIALS

High-melting-temperature oxide ceramic supports for tungsten filaments needed in vacuum tubes developed for the radio industry are produced in the Research Laboratory under the direction of Louis Navias.

APPLIANCES

Demonstrating the rapid consumer acceptance of a product introduced only four years earlier, the one millionth GE electric refrigerator is presented to the Henry Ford Museum.

INDUSTRIAL EQUIPMENT

Specially designed high speed vertical-mount motors for spinning rayon are introduced. These motors meet the special demands of a new industry.

TRANSPORTATION

Increased capacity AC-DC locomotives from the Erie Works will handle fifteen 80-ton Pullmans at an average 65 mph express speed, for the New York, New Haven and Hartford Railroad. The locomotives also have double-ended operation to ease switching.

ORGANIZATION

Everett S. Lee succeeds Lewis T. Robinson as head of the General Engineering Laboratory.

POWER GENERATION

Improvements in the efficiency of steam turbines reach a point where it requires about 1.5 lbs of coal to produce 1 kilowatt-hour of electricity, compared to more than 3 lbs needed ten years earlier for the same output.

COMMUNICATIONS AND ELECTRONICS

Photo-electric control equipment has now been developed to a point where its position in the industrial field is definitely established.

MEDICAL EQUIPMENT

The most powerful X-ray machine developed, a 900,000-volt unit, is installed at Memorial Hospital, New York City. Its record high voltage is made possible through use of the "cascade" principle developed by William D. Coolidge and Ernest E. Charlton.

Automatic photoelectric control of a GE water cooler. Similar controls are gaining widespread use in industrial control processes.

Ernest E. Charlton (l.) and William D. Coolidge with 900,000 volt X-ray tube.

OWEN D. YOUNG AND GERARD SWOPE

Gerard Swope
1872-1957

The story of Owen D. Young (the "D" signifying no particular name) is the American story of the farm boy who made good. He became an industrial statesman whose heart remained with his home community and who gave his time unstintingly in public service to his state, the nation, and the world.

The path he trod from the farm led to the threshold of the White House. From 1924 through 1932, his name figured prominently as a possible Democratic nominee for President, but he refused to encourage the hat-flingers.

Young was born in Van Hornesville, N.Y., on October 27, 1874. He was 16 years old when his parents mortgaged the farm to send him to St. Lawrence University at Canton, N.Y. Upon his graduation in 1894, he sought permission to work his way through Harvard University's Law School but was turned down. He turned instead to Boston University where he completed the three-year law course in two years, at the same time supporting himself by tutoring and library work.

Owen D. Young
1874-1962

After his graduation from law school in 1896, Young joined the Boston Law office of Charles H. Tyler and within a few years was a partner. He handled much litigation for the electrical engineering firm of Stone & Webster and eventually came to the attention of Charles A. Coffin, the first president of General Electric.

One morning in 1913, Coffin asked to see him. Young told his wife he expected to be "spanked" because he recently had inflicted a legal defeat upon General Electric.

Instead, Coffin invited him to become the Company's Chief Counsel and Vice President in Charge of Policy. When Young accepted promptly, Coffin observed that salary had not been mentioned. Young replied:

"I would like to have you pay me less rather than more than those holding similarly responsible positions. I wish to be sure of earning what I get. I would much rather have the organization feel that I am underpaid than overpaid."

Owen D. Young posing as "Keystone Cop" during lighter moment at Association Island.

LEADERS OF GENERAL ELECTRIC

In 1922 he succeeded Coffin as chairman of the board of General Electric, while Gerard Swope was appointed president of the Company

Young appeared on the international scene, in which he was destined to play a major role, as a member of the German reparations commission in 1924. Out of this international conference came the Dawes plan. When the American delegation returned, General Charles G. Dawes referred reporters seeking details to Young. General Dawes told them, "Young knows more about it than anyone."

In 1929, Young was called upon to head another committee of experts to unify further German payments. This group drafted the Young Plan for handling reparation payments on the basis of a new total sum.

His talents as a conciliator and mediator and his abilities to achieve agreement among men of divergent views came into full play in 1919 when, at the request of the government, he created the Radio Corporation of America to combat threatened foreign control of America's struggling radio industry. He served as RCA's board chairman until 1929.

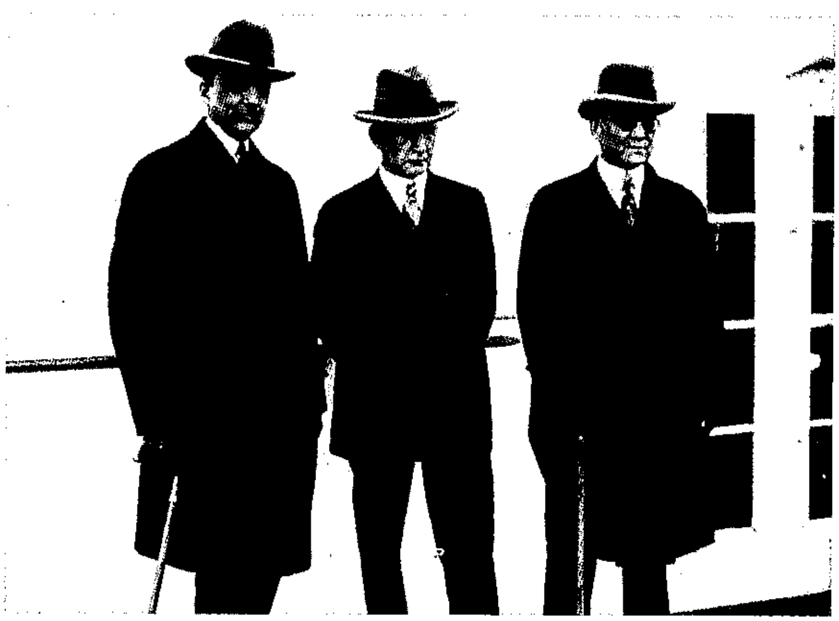
Long active in education, he was a trustee of St. Lawrence University from 1912 to 1934, serving as president of the board the last 10 years. He was a member of the New York State Board of Regents, governing body of New York's educational system, until 1946.

Governor Thomas E. Dewey called upon him in 1946 to head the state commission which laid the groundwork for a state university system in New York. Although the commission represented a wide range of views and opinions, Young achieved a surprising unanimity which resulted in a report containing recommendations adopted by the legislature.

Gerard Swope, who started out with the General Electric Company in 1893 as a helper at $1 a day, became president of GE in 1922, and served in that post for nearly 20 years.

His career and his personality were once summarized by an associate: "Probably no man in his generation has been more ardently devoted to his country and its interests and more willing to devote his great energies and abilities unsparingly to this work than Gerard Swope. These qualities have manifested themselves in everything with which he has come into contact. And in all his activities, whether as business executive or economic leader, his thinking is of a fundamental and analytic quality undoubtedly influenced by his engineering training."

He was born in St. Louis, Mo., on December 1, 1872. As the result of a desire to see the Chicago World's Fair in 1893, he went to that city while still an undergraduate at Massachusetts Institute of Technology and became a helper at the GE Chicago Service Shop.



American Members of the Dawes Committee. From left to right: Owen D. Young, Charles G. Dawes, Henry M. Robinson.

Swope was graduated from M.I.T. in 1895, with a Bachelor of Science degree in electrical engineering and returned to Chicago, this time in the shops of the Western Electric Company. Four years later, he went to St. Louis as manager of the Western Electric office, and in 1906 was transferred to Chicago. He went to New York as general sales manager two years later.

In 1913, Swope was named a vice president and director. Four years later, he visited the Orient, organizing a Chinese Western Electric Company and promoting trade interests and telephone service in the East.

During the first World War, Swope served on the War Department General Staff in connection with the Army's procurement and supply program. For his outstanding achievements, he was awarded the Distinguished Service Medal by the President of the United States and was named a Chevalier of the Legion of Honor by the French government.

He was brought to General Electric in 1919, by Charles A. Coffin, then president. When the foreign department of GE was enlarged that year into a new organization, the International General Electric Company, Swope became its first president. He was elected president of General Electric in May, 1922.

Young and Swope worked out a division of responsibilities that was to continue as long as they held office. As Young described it, "one of us shall act as captain of the ship, the other as navigator". He would concern himself with policy, while Swope would oversee production, research, engineering, and sales. Yet, in the words of Philip Alger, in *The Human Side of Engineering*, "They were so much in accord that it is hard to say whether any given policy was due to one or to the other."

Under Young's and Swope's direction, General Electric began the extensive manufacture of electric appliances for home use. Before 1922, the only product sold directly to the public, on the basis of mass production and wide distribution, was the incandescent electric lamp. The Company had until then concentrated its efforts on producing equipment for generating, transmitting, and controlling electricity.

The introduction of a host of electrical consumer goods required extensive enlargement of GE's advertising, marketing, distribution, and service organizations — not to mention its engineering and manufacturing facilities. But the commitment of resources was successful. It helped revolutionize the American household, speeded the electrification of farms, factories and transportation systems and increased the demand for the Company's utility-related equipment.

The onset of the Depression did not spare General Electric, but the diversification measures which Young and Swope had instituted protected it from the fate of countless other industrial concerns. At the same time, their plans for improving the economic security and general welfare of General Electric workers helped cushion the blows of the Depression and other personal misfortunes. Though at first considered radical by some, these served as prototypes for other segments of American industry.

Plans which they introduced or expanded included the General Electric Mutual Benefit Association, providing sickness and death benefits; free and contributing group insurance; educational scholarships and loan funds; and a savings plan made possible by organization of the General Electric Employees Securities Corporation providing bonds as a medium for investment of employee savings.

Secretary of Labor Frances Perkins and GE president Gerard Swope during broadcast of symposium on government and business cooperation.

The most outstanding example of Young's and Swope's distinctive contributions in the area of employee benefits, however, was an unemployment insurance plan, which greatly influenced thinking on this subject throughout the United States, both in industry and in government. It preceded the Social Security Act by more than five years.

One of the more publicized demonstrations of Gerard Swope's genius for evolving solutions to the problems of industry was reached in 1931, during the Depression, when he proposed the "Swope Plan" for stabilization of industry. For this and other social services, he was awarded the gold medal of the National Academy of Social Sciences in 1932.

On November 17, 1939, the team of Young and Swope, in a manner reminiscent of many of their previous actions, jointly announced, "We took up these offices together, and we wish to lay them down together." — January 1, 1940.

They were succeeded by Philip D. Reed and Charles E. Wilson, chairman and president, respectively. In 1942 the needs of the War effort caused Reed and Wilson to resign their posts and to enter government service. Reed left for London to become deputy to W. Averell Harriman who headed the Lend Lease Mission to England; and Wilson assumed the post of vice chairman of the War Production Board.

Young and Swope took up the General Electric reins again. "I like this resurrection so well that I'm less apprehensive about the next one," Young smilingly told a reporter.

He and Swope stepped aside once more, late in 1944, to make way for the return to the Company of Reed and Wilson.

Thus ended more than twenty years of their leadership which had produced one of the greatest periods of expansion in the history of the Company, sustained it through one of the country's greatest economic declines and mobilized it to supply the resources that helped America and its allies to be victorious in World War II.

Owen D. Young (l.) and Gerard Swope after presentation of gold medal award of National Academy of Social Sciences to Swope.

Keep thy Shop and thy Shop will keep thee

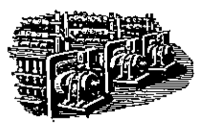
[The Sayings of Poor Richard]

Just Published for 1931

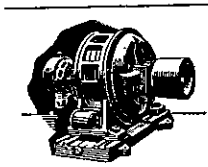
AN

Almanack

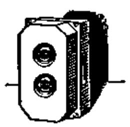
containing wise, thought-provoking suggestions for modernizing industrial plants and published in the firm belief that a penny spent on modernization to-day will be worth ten pennies spent to-morrow.



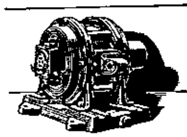
A certain group drive required 164 large bearings and 3600 feet of heavy belting. It was replaced by G-E individual direct-motor drive with 20 small bearings. Maintenance dropped from 65 cents to 12 cents per ton of product.



High power-factor is as beneficial to the plant as to the vendor of electricity. In many cases, the G-E sales engineer can show you how to pay for "leading-power-factor" synchronous motors out of the economies that follow their installation.

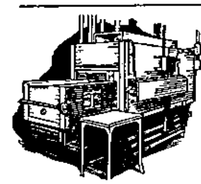


Instead of saying, "I can't use a synchronous motor here because I don't want it to stop at every voltage disturbance," call in the G-E sales engineer and ask him to show you the G-E time-delay devices which keep not only these motors, but all induction motors, on the line for all temporary voltage dips.

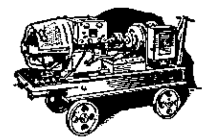


If power conditions in your plant will stand full-voltage starting, there are a number of G-E motors now available for this service that will greatly simplify your control equipment.

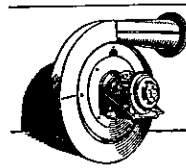
Continued bearing trouble was traced to an uninstructed night man who slapped off the belts by mishandling the starter and kept tightening them up to make them stay on. A G-E magnetic starter would have saved six months of trouble.



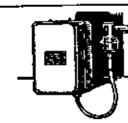
A New England manufacturing plant modernized its heat-treating department, at the suggestion of a visiting G-E heating specialist, by replacing four old fuel-fired, batch-type furnaces with a G-E automatic electric conveyor furnace. Handling costs dropped 60 per cent; production was tripled; the products were much improved; and the former high maintenance costs dropped out of the picture.



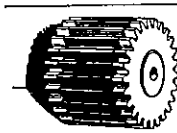
Hundreds of plants are getting "out of the red" and scores of little plants are growing big because they called in the G-E arc-welding specialist to help them modernize their products with arc welding—the greatest of modernization tools. It's almost impossible to strike an arc without improving design or cheating the scrap heap with a neat repair.



No better time to replace those old, inefficient blowers in the forge shop with modern G-E blowers that speed up production by maintaining uniform pressure on each furnace and reduce power costs because they are so efficient. Also, the operation of your cupolas can be greatly improved, and a substantial saving in coke effected, by installing a G-E cupola blower with automatic blast-gate control.



Give your plant engineer some G-E Thyratron or photoelectric tube equipments to play with and you'll be surprised at the number of places where he can use them to speed production, simplify control, and cut costs.



After you've replaced a stripped pinion on a motor shaft a few times, ask the G-E sales engineer to send you a Fabroil or a Textolite pinion. They outlive most other pinions by wide, wide margins. They practically eliminate noise, too.

Modernization Reduces Costs — Increases Profit

There are any number of ways in which the G-E sales engineer can help you to modernize. Ask him about them when he calls; or write the nearest G-E office.

GENERAL ELECTRIC

200-426 H

This advertisement, which appears this month in twenty industrial magazines reaching more than 243,000 men throughout the nation's industries, is part of the "Promote Modernization" campaign being conducted by the Industrial Department

NOBEL PRIZE FOR CHEMISTRY IS AWARDED TO IRVING LANGMUIR

The Monogram
December, 1932

A THRILL of pride ran through all the General Electric organization when the news dispatcher announced that Dr. Irving Langmuir, associate director of the Research Laboratory at Schenectady, had been accorded the highest honor that any scientist can receive — a Nobel Award. It was given to Dr. Langmuir for outstanding research work in chemistry.

In the 31 years during which the awards, created by provisions of the will of the late Alfred B. Nobel, Swedish scientist, and administered by the Swedish Academy of Science, have been given, only one other American chemist has received this award — Dr. T.W. Richards, in 1914.

Other Americans who have attained to the distinction of a Nobel Award include: Physics, A.A. Michelson, R.A. Millikan, and Arthur Compton (divided with C.T.R. Wilson, of England); medicine, Dr. A. Carrel and Dr. Karl Landsteiner; literature, Sinclair Lewis; the promotion of international peace, Theodore Roosevelt, Elihu Root, Woodrow Wilson, Charles G. Dawes, and F.B. Kellogg.

Honors given in recognition of his scientific work are by no means new to Dr. Langmuir. Among the awards he has received are:

The Nichols Medal, awarded to him on two different occasions by the New York Section of the American Chemical Society, once in 1915 for his work on chemical reaction at low pressure, and in 1920 for his work on atomic structure; the Hughes Medal from the Royal Society of London for his researches in molecular physics; the Rumford Medal, awarded by the American Academy of Arts and Sciences for his thermionic researches and his work on the gas-filled incandescent lamp; the Cannizaro Prize, awarded him by the Royal Academy of Lincei, Rome; the Perkins Medal; and the Chandler Medal; and this year *Popular Science Monthly* awarded him its annual medal and honorarium of $10,000 as an American who has done outstanding scientific work.

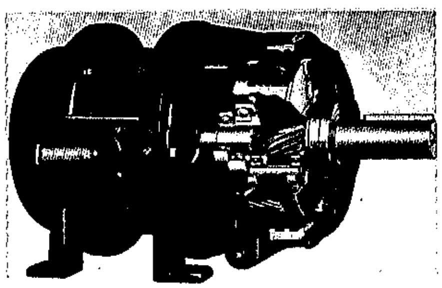
His outstanding achievements from a practical viewpoint are the development of the high-intensity incandescent lamp, an improvement which, it is estimated, saves the American public a million dollars a night; his work on vacuum tubes, with all the effect it has had on radio broadcasting, on electrical control operations, and in other fields; his work on electric welding by the atomic hydrogen method. In addition to this, scientists attach a very high value to his many published papers.

With a simple film balance and trough, Langmuir explored complex phenomena at liquid surfaces. He explained such varied occurrences as the formation of oil films on water and the diffusion of material through the walls of living cells in terms of a novel conception of short-range forces acting on surface molecules. The originality and fundamental importance of the work led to the Nobel Award.

King Gustavus V of Sweden presents Nobel medal to Irving Langmuir on December 10, 1932.

1932

World's largest lamp, 50,000 watts, and smallest, "grain of wheat" lamp used in surgical instruments.



Cutaway view of typical GE gear-motor.

LIGHTING

The mogul "bi-post base " lamp is devised by Daniel K. Wright of the Lamp Development Lab. By using two heavy metal prongs as the lamp's base and as its electrical connections, stronger units can be constructed for high power lighting applications in the 10,000, 20,000 and 30,000-watt range.

Photoflood lamps are developed by Gwilym Prideaux and others at Nela Park. The low-cost bulbs produce high light intensities for 3-10 hours and are designed for photography and other short duration uses.

INDUSTRIAL EQUIPMENT

Gear motors for slow-speed drives from 600 to 13 rpm are introduced in 3/4 hp to 75 hp sizes to provide industry with compact, easily installed drives.

APPLIANCES

The GE oil burning furnace is placed in production. Burner units are manufactured in Schenectady, boilers in Pittsfield, and the complete heating package is assembled in the customer's home.

The Air Conditioning Department is established to handle electric devices for home heating, humidifying and temperature control.

New year-round room air conditioner. GE oil-burning furnace.

The first GE dishwashers are marketed. Consumer financing by the General Electric Contracts Corporation is made available to meet the widespread demand for the great variety of new electric appliances.

T. S. Fuller, Roy Moore and Louis Navias of the Research Laboratory develop a motor-driven razor sharpener.

MATERIALS

The Pittsfield Works announces the use of "Pyranol," a family of organic liquids having superior dielectric insulating properties, which make them particularly suitable for capacitors of large size. Frank M. Clark of the Works laboratory was principally responsible for their development.

TRANSPORTATION

The French superliner "Normandie" is launched, propelled by four of the most powerful motors ever built — 40,000 hp each, manufactured by GE Associate, Als-Thom, in France. This 1029-foot ship is the largest commercial vessel in the world and is destined to usher in a new era of superliners.

ORGANIZATION

Willis R. Whitney retires from his position as Director of the Research Laboratory and is replaced by William D. Coolidge.

The liner "Normandie" — propelled by four of the most powerful electric motors ever built.

Dr. Whitney Retires? Pooh!

Under the above heading, the *New York Sun* of November 1, 1932 said, editorially:

"The General Electric Company announces that Dr. Willis R. Whitney has 'retired.' It means that he has been relieved of the obligations that devolve on the head of its research laboratory. In one of his numerous enlightening asides Dr. Whitney, speaking for humanity at large, has said that 'we are lamentably bound by words.' The corporation bulletin illustrates the truth of his incidental declaration.

"Dr. Whitney in seclusion, Dr. Whitney in retreat, Dr. Whitney withdrawn from circulation — these are unthinkable. The Whitney intellect has served knowledge too long to be suspended in its operations by a mere rearrangement of opportunities. The Whitney curiosity has so persistently projected into the abyss of man's ignorance that no shifting of titles can restrain it from future excursions into that fascinating, unplumbed gulf. The Whitney utilitarianism is too robust to be manacled by assignment to non-routine duties. The Whitney spirituality is too pervading to be definitely engrossed on a scroll and filed away in a cabinet, no matter how artistically the engrossing be done or how elegantly the cabinet be fashioned.

"And, ultimately, Dr. Whitney possesses a sense of humor and a quality of wit which veto the notion that a useful man should or can retire."

THE GENERAL ELECTRIC SALES FORCE...HELPING TO BEAT THE DEPRESSION...

OUR JOB

THE SPIRIT with which these difficult times have been met is wonderful, and I can say to each man in the field that his cooperation, loyalty, and continued evidence of determination to get all the business possible are recognized and very deeply appreciated by the officials of our Company.

E.O. Shreve, Chairman — General Sales Committee

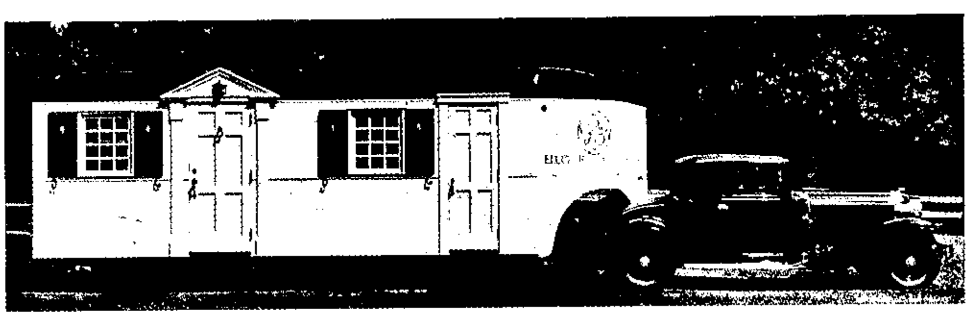
I believe brighter times are not far away. We must recognize, however, that our business lags behind general business and, therefore, we still have some serious problems to solve.

While a good job has been done, I am satisfied that we *can* and *must* do even better. If each one could walk down the streets of our factories, he would picture more vividly the tremendous responsibility the Commercial Department has in providing work, and with that vision would grow a greater determination to get more of the business being offered and to do more *creative* selling. Think it over and realize that not only the Company and our own economic lives, but the economic lives of many other workers depend upon *our* success.

Call on more customers (always with an optimistic message), study our lines, analyze successful methods of sales technique, seek ideas from others on important transactions, and, above all, build a determination to get more business by real, *creative* selling. We at the General Office will back you on any reasonable sales proposition.

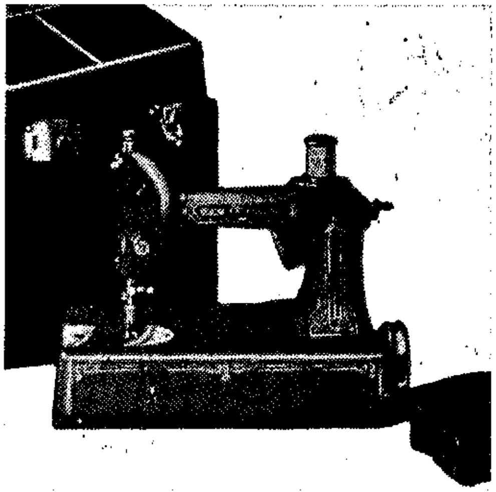
We are proud of you all! These trying years have been, above all else, a test of men. We know *our* sales organization has stood the test, and we have confidence that that kind of men will go on to greater sales results through thoughtful planning and a determination which *must* bring success. With such a spirit, I am sure you will have the satisfaction of seeing a large number of men back at work this year because of a larger volume of sales than that obtained in 1932.

E.O. SHREVE
ASSISTANT VICE-PRESIDENT

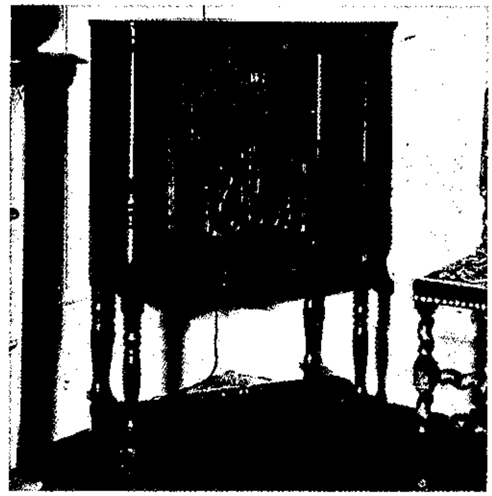


. . . and Creative selling they did!

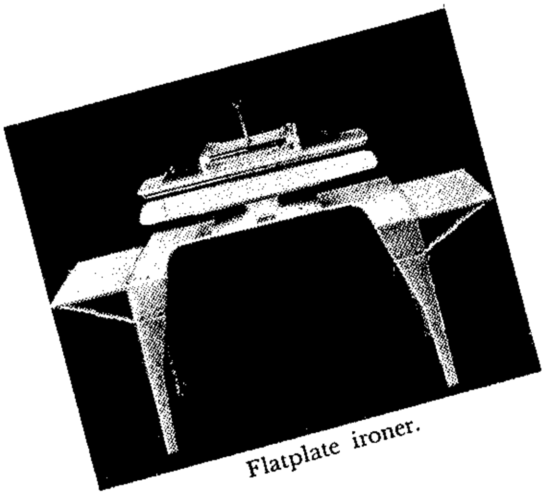
SOME NEW PRODUCTS FOR THE HOME



Portable electric sewing machine.

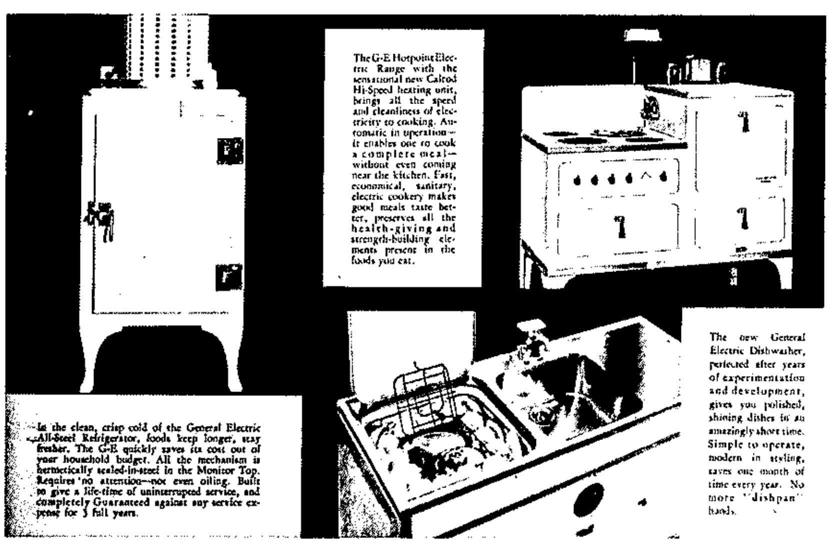


Lowboy radio, Model H-31.

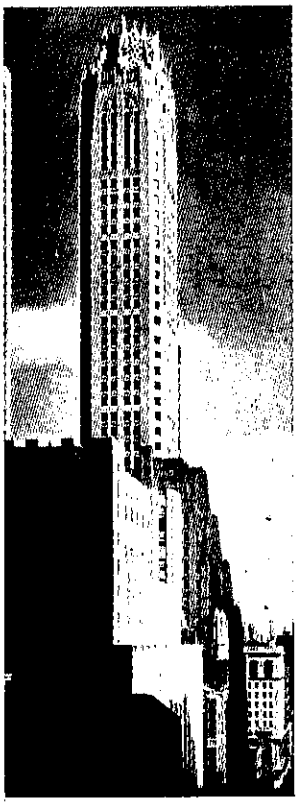


Flatplate ironer.

Clothes washer with spin basket.



1933



570 Lexington Avenue
New GE Headquarters

POWER GENERATION

Two waterwheel generators are under construction at GE — Schenectady for Boulder Dam. Each unit is greater in electrical capacity (82,500 kva) and physical dimensions than any previously constructed. With a height of 32 feet above floor level, each unit will weigh more than 2 million pounds.

TRANSPORTATION

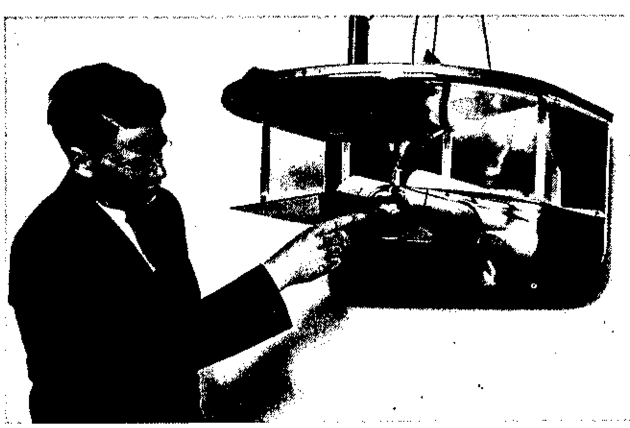
E.F.W. Alexanderson demonstrates caboose-to-engine radio communication in Schenectady. Inductor coils are suspended from the train to transmit and pick up signals to and from the rails and direct them to transmitting and receiving equipment. This communication system contributes immeasurably to fast, safe railway service.

LIGHTING

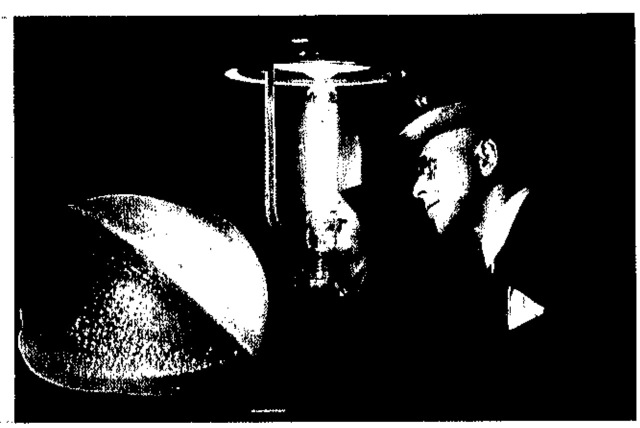
The three-way lamp is developed for multi-level illumination. Each of its two filaments can be turned on independently with a multiple switch or used together to increase the lighting level.

The Lamp Department introduces the high efficiency sodium-vapor lamp for street and open area lighting. Although such lamps had been in existence for some years, their lifetimes were limited by deterioration of the glass. Louis Navias and others at the Research Laboratory and at Nela Park produced glass coatings that resist the damaging effects of the sodium vapor.

A 400-watt, mercury-vapor lamp is also introduced for "whiteway" street lighting and floodlighting.



Sodium-vapor lamp for highway illumination.



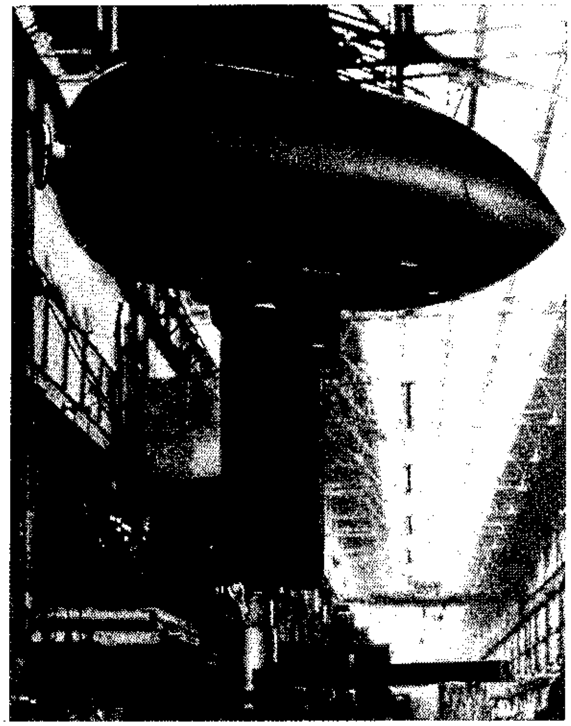
Lighting pioneer C.A.B. Halvorson examining new mercury-vapor lighting unit.

INDUSTRIAL EQUIPMENT

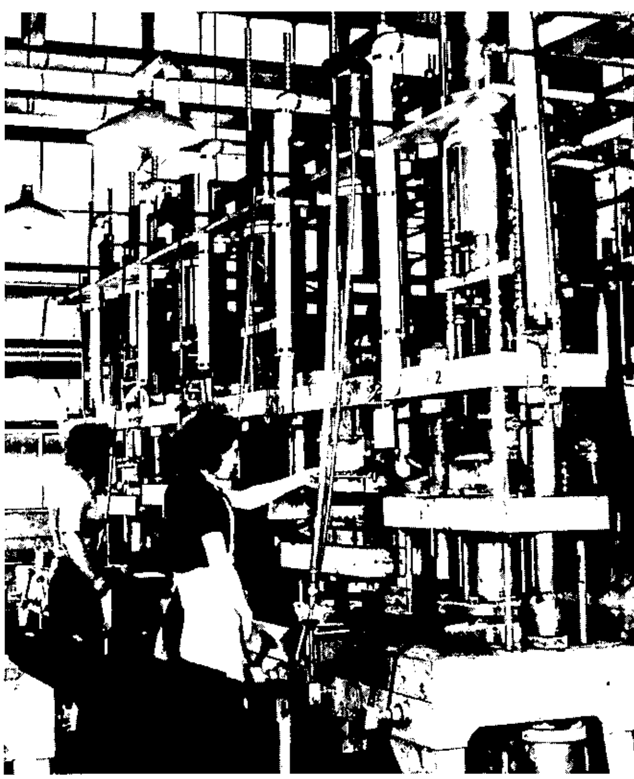
A variable speed AC motor using thyratron tube control is developed. Rated at 400 hp, 4500 volts, 3-phase, zero to 925 rpm, this motor offers industry continuously variable speed with a control system having essentially no moving parts.

A specially designed motor, rated 200 hp, 3600 rpm, is built for testing airplane propellers at Langley Field.

The world's largest supersynchronous motor, rated at 800 hp, is applied to flour mill drive. This motor, with a stator that revolves at start, is able to accelerate heavy equipment to synchronous speed.



"Zeppelin"-shaped induction motor for Langley Field propeller testing.



Operating molding presses for plastics.

GE plastics exhibit for 1933 "Century of Progress" world's fair.

1934

LIGHTING

The lumiline tubular incandescent lamp, with contacts at both ends, is placed on the market for decorative and specialized lighting applications.

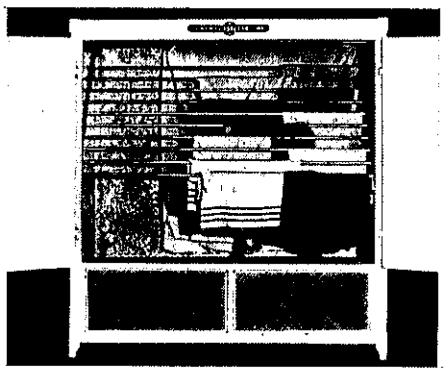
A fluorescent lamp 10-in. long and 3/4-in. diameter is constructed by a group from Nela Park, including Richard Thayer, Eugene Lemmers, Willard A. Roberts and George E. Inman.

Miniature lamps with built-in lenses are introduced for "fountain pen" flashlight and other small lighting devices.

George Inman (l.) and Richard Thayer (r.) examining fluorescent lamp.

APPLIANCES

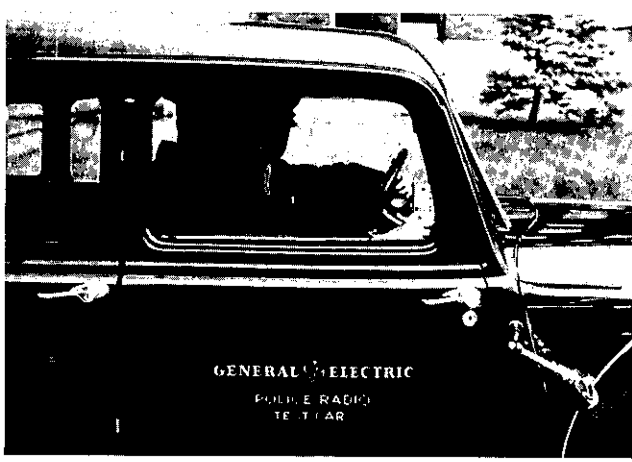
General Electric announces a line of domestic gas-burning furnaces. A new household electric clothes dryer is introduced. It will handle as many as eight sheets or the contents of an 8-pound washer at one time.



The final link in the home laundry arrives — the GE cabinet dryer.

COMMUNICATIONS AND ELECTRONICS

Mobile two-way radio is developed and installed in various police agencies throughout the country. The system also permits mobile radio tie with telephone lines for long distance or local phone calls.



Police radio test car.

Communicating with police automobiles by radio from police headquarters.

INDUSTRIAL EQUIPMENT

GE engineers design a new line of explosion proof, fractional horsepower motors especially designed for gasoline vending pumps.

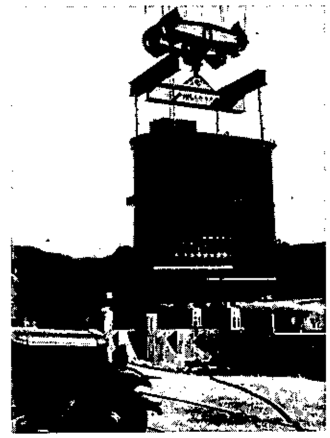
POWER GENERATION AND DISTRIBUTION

In building apparatus for installation at Boulder Dam, GE continues to set new records: 287,600-volt water-cooled transformers, and high voltage impulse oil circuit breakers operate at the highest commercial voltage ever.

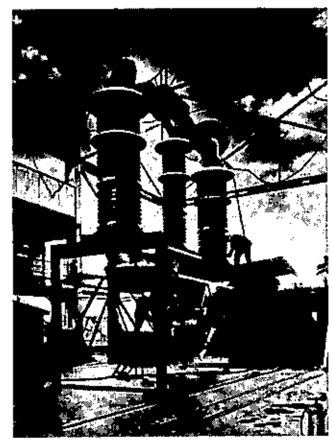
TRANSPORTATION

The "Zephyr," the first streamlined diesel-electric train, equipped by GE, makes a "dawn to dusk" run from Denver to Chicago, 1017 miles, on the Chicago, Burlington, and Quincy Railroad. Speeds up to 112-1/2 mph and an average of 77-1/2 mph are achieved.

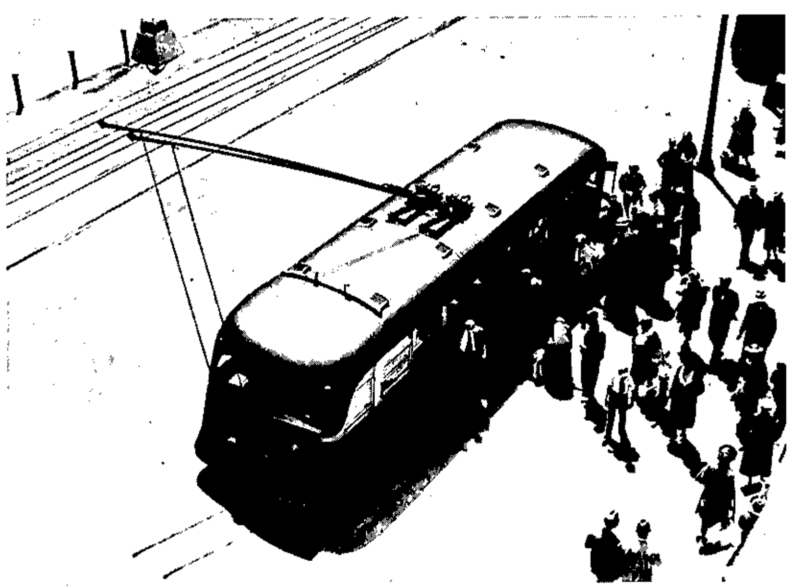
A trolley bus uses trolley lines to climb a 6% half-mile grade in Weehawken, N.J., to the top of the Palisades, and then disengages from the lines to run on gas. This flexibility is made possible by a dual controller and GE motors designed for operation in series with trolley power, and in parallel with bus generator power.



287,000-volt transformer for Boulder Dam.



Record-size oil circuit breaker for Boulder Dam.



Pullman trolley coach equipped with GE two-motor drive.

1935

Night baseball at Crosley Field, illuminated by GE Novalux lamps.

The new "Disposall" garbage disposer.

LIGHTING

A two-foot-long fluorescent lamp is displayed at the annual convention of the Illuminating Engineering Society. A display card reads, "The fluorescent lumiline lamp — a laboratory development of great promise." The new lamps provide more light per watt of energy consumed than filament lamps and throw off less radiant heat.

The first major league night baseball game is played at Crosley Field, Cincinnati, Ohio under GE Novalux lamps. The Cincinnati Reds defeat the Philadelphia Phillies by a score of 2-1.

APPLIANCES

The first household electric food waste disposer, the "Disposall", is introduced by General Electric. In recognition of its inventor, the new product is designated, within the Company, as "Bill Merrill's electric pig."

TRANSPORTATION

The most powerful single cab locomotive, the streamlined GG-1, is built by the Erie Works for the Pennsylvania Railroad's extensive electrification program. This 460,000-lb, 79-ft unit has an all-welded cab and is capable of safe running speeds up to 90 mph.

MATERIALS

The Research Laboratory improves upon the properties of Alnico, making it the most powerful magnetic material available, and capable of supporting more than 60 times its own weight.

POWER GENERATION AND DISTRIBUTION

GE demonstrates a new method of high voltage DC transmission over the Mechanicville to Schenectady lines of the New York Power and Light Corporation using thyratron and phanatron tubes to convert alternating current to direct current and back again.

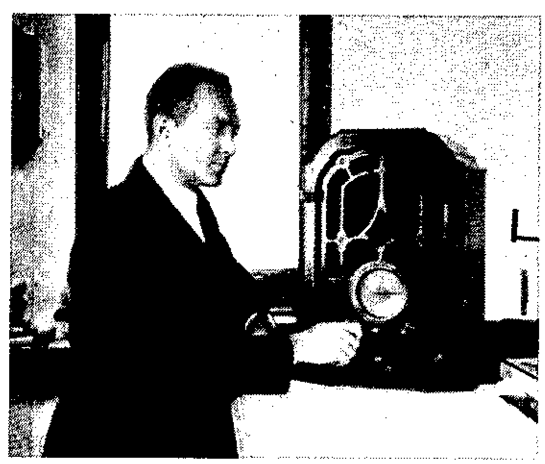
Research by C.G. Suits on high pressure arcs results in greatly improved high current switchgear. His work also produces basic knowledge of the behavior of arcs in gases under various pressure and temperature conditions.

COMMUNICATIONS AND ELECTRONICS

Metal-enclosed vacuum tubes — better shielded, smaller and more rugged than their glass counterparts — are developed by W.C. White and others at the Research Laboratory. The metal construction is made possible by new alloys and improved lead-in seals.

Alnico magnet (nine ounces) lifting Underwood typewriter.

C. Guy Suits.



Rear Admiral Richard E. Byrd with his all-wave radio in the cabin of the "Jacob Ruppert" in which he set sail for the Antarctic.

PIONEERING IN MOTOR TECHNOLOGY

Howard Maxwell
1879-1967

Howard Maxwell

Engineer, innovator and business leader with courage and understanding of men, these are the qualities that gave Howard Maxwell his place in the archives of motor achievements. As Managing Engineer and then Manager of General Electric's Schenectady Induction Motor Department, he earned the love and respect of all who were engaged in the manufacture of these new workhorses of industry.

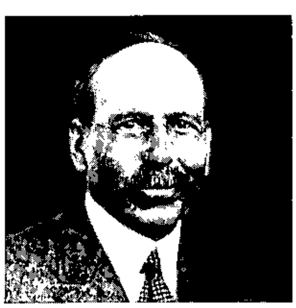
A 1900 graduate from the University of Kansas, Howard Maxwell joined the General Electric test program and became an engineer in motor design at Schenectady. Among his early successes with induction motors were the first large steel mill motors. These giant machines, installed in 1909, drove the main rolls of a new Gary Steel Mill plant. They were assembled at the site without previous test, a courageous undertaking for all concerned, and their success was a major achievement. Some years later, Maxwell designed the motors for the aircraft carriers "Lexington" and "Saratoga". This time, following his motto "try it first," he built and tested a 500-horsepower model. Even so, the extrapolation to 35,000 horsepower to drive these huge ships required courage and determination.

As induction motors began to take their place in industry, they soon began to be needed in great numbers, but design and manufacture of suitable rotors were beset with many problems. Following earlier attempts with cast aluminum windings, Maxwell invented and developed centrifugally cast aluminum windings. This method of manufacture produced motors with such successful performance that the entire motor industry soon adopted this construction.

When the motor business grew to large proportions, the Induction Motor Department was formed with Maxwell head of both engineering and manufacturing. He had a most friendly and altogether charming manner and took a great interest in all who worked for him, always keeping in mind their ambitions and abilities and, together with his associates, arranging their education, transfer or promotion in a farseeing way. During the great depression of the 1930's, with his characteristic courage, in the face of orders to reduce his staff, he kept his organization intact with greatly reduced time but nevertheless with everyone on the payroll.

In the late 1930s, Maxwell became convinced that American manufacturers were getting far less output from a frame size than was possible by more effective design. He backed this with test data and provided leadership and drive to convince the National Electrical Manufacturers Association, responsible for the standards, that American motor companies should redesign their motors to reduce costs without decreasing quality.

Maxwell had long planned to retire in 1941, but after Pearl Harbor, he felt that motors would have to be produced in large quantities and that he could do more as manager of the Motor Department than anywhere else. He stayed on until after the war was over and conditions had returned to near normal. During his time and mostly under his direction, he had seen the output of a fixed-size motor frame go from 7-1/2 horsepower to 40 horsepower. His Department had designed and manufactured the standard and special lines of motors needed by its sales and application engineers to make GE the outstanding leader in the induction motor field. While doing all of this, Howard Maxwell earned for himself the highest regard of his employees and his associates, world-wide.



H.G. Reist

C.J. Koch

M.H. Wells

Philip L. Alger

Philip L. Alger

The philosophy, "Rules are made to be broken — in a nice way," characterizes the man whose courage, foresight, and engineering ability brought many important innovations to electric power during the first half of this century. In 1894, the year this man was born, Steinmetz, Pupin and others engaged in extensive discussions of the merits of the induction motor that Tesla had given to the world a few years previously. It became the role of Philip Alger, engineer and mathematician, to further unravel its mysteries and to make the many technical contributions which would earn for him the name, "Mr. Induction Motor."

Alger's General Electric career began in 1919 after he had served as a lieutenant in the Ordnance Department, U.S. Army. His early work on motor reactance produced first induction motors, and then synchronous motors capable of direct, across-the-line starting, greatly simplifying motor controls. His 1928 AIEE paper, "The Calculation of Armature Reactance of Synchronous Machines," remains a classic in the annals of rotating electric machinery.

In 1929 Alger was appointed to the staff of the vice president of engineering to sponsor and coordinate developments in electric apparatus throughout the General Electric Company. He became a leader in professional engineering societies, in industry-wide standardization in education, and in local government, as well as in technology. He was impressed by the observation that men are creatures of habit, and he realized that one must first have the wisdom to recognize what is sound and then have the courage to propose it, even when this means breaking with tradition.

Alger saw clearly that for the greater expansion of electrification in industry, motors must be made smaller and lighter in weight for the same output. This task required the critical examination of many traditions in design engineering and among motor users. His many published papers give only a glimpse of the extent of his contributions as a worker and leader of the committee and working groups of AIEE and ASA which led ultimately to the adoption of a succession of new NEMA standards for motors in the 1940s. Motors built to those standards weighed less than a third as much as their predecessors of the late 1920s. They were quieter and did their jobs as well or better.

Alger also was a leader in bringing about acceptance standards for new synthetic insulations introduced in the 1950s, resulting in further reductions in motor size and improved insulation performance.

Following his retirement from General Electric in 1959, he continued his interest in motors as Adjunct Professor of Electrical Engineering at Rensselaer Polytechnic Institute. His knowledge and enthusiasm — together with his published books and numerous technical papers — continued to bring a following of many students to the power field.

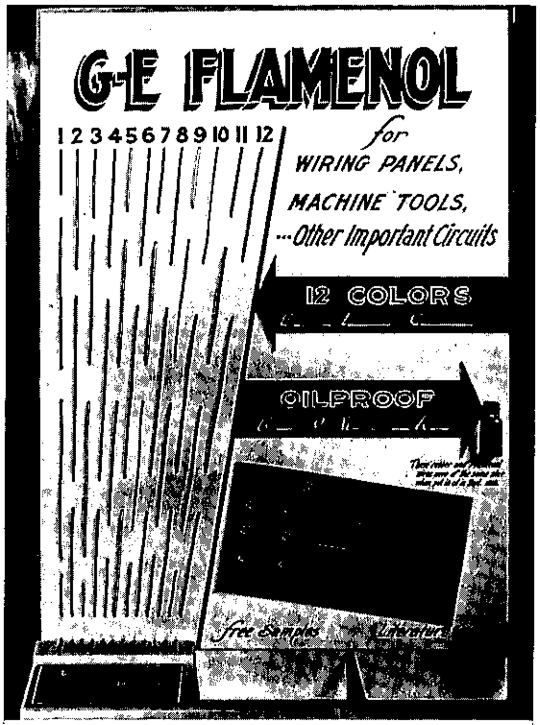
Throughout his career, Philip Alger has paralleled his technical work with equally vigorous pursuits in other areas. He says with pride that he has tried never to refuse an invitation, an advice of Benjamin Franklin. This has brought him to the fields of professional and ethical standards for engineers, engineering education and recruiting practices, and local government, all of which have enriched the lives of others as well as his own. His career truly epitomizes the complete professional engineer.

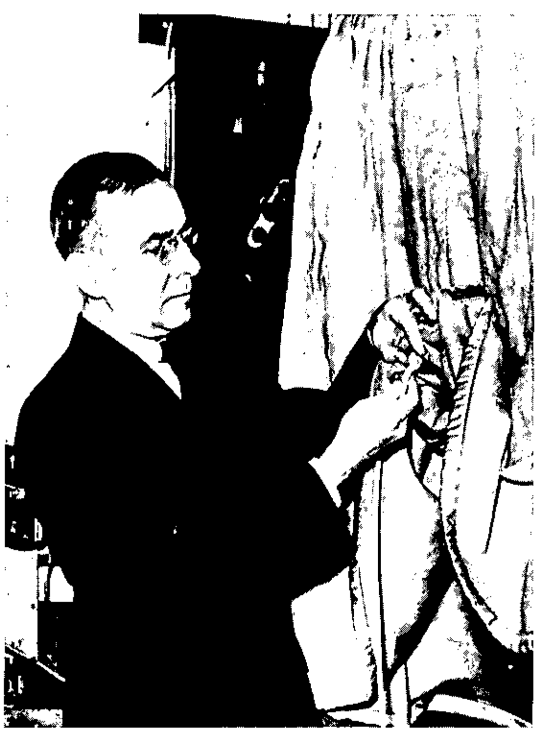
K.A. Pauly

P.O. Noble

L.E. Hildebrand

1936





W.K. Kearsley and electric blanket.

LIGHTING

The coiled-coil filament lamp is introduced in standard lamps. First patented in 1917 by B.L. Benbow, the double coiling of the tungsten filament increases the efficiency of a 60-watt lamp by more than ten percent.

The San Francisco-Oakland Bay Bridge is opened in California, lighted by more than 1000 GE sodium luminaires.

MATERIALS

Flamenol®, a non-combustible, oil- and moisture-resistant insulation is developed for copper conductors used in home and industrial wiring. The new polymer, made by plasticizing polyvinyl chloride, was perfected by J.G.E. Wright, Moyer M. Safford and others under the direction of A. Lincoln Marshall, head of the Chemistry Section at the Research Laboratory.

Molding of wiring devices is begun at its Providence, R.I., plant by GE affiliate Monowatt Electric Co. The corporation was formed primarily to meet the rapidly growing chain store market for consumer wiring materials.

John H. Payne invents the "silent" mercury switch for home use. The mercury makes contact between metal caps through an opening in a ceramic barrier invented by Louis Navias.

APPLIANCES

W.K. Kearsley of the Research Laboratory invents the electric blanket. The first model consists of two sheets sewed together with flexible insulated copper wire between them. Kearsley had also invented a vascular exercise machine designed to help improve blood circulation in the legs of arteriosclerosis patients.

TRANSPORTATION

The Erie Works is building another "world's first" for the Union Pacific Railroad. It is a locomotive with a closed high pressure steam boiler-condenser-steam turbine system, whose steam is condensed to water for recirculation, eliminating the need to stop en route to replenish water.

COMMUNICATIONS AND ELECTRONICS

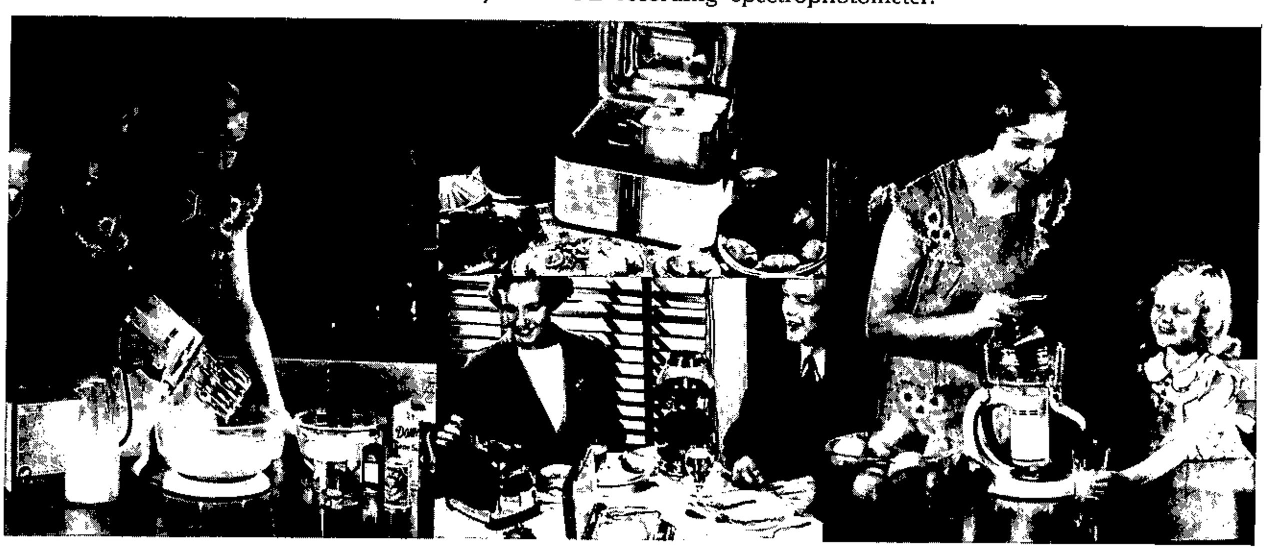
The General Engineering Laboratory announces the commercial availability of a recording spectrophotometer. This instrument, invented by Professor A.C. Hardy of MIT, measures the spectral reflectance or transmittance of materials and will be used to match colors accurately.

Sealed-ignitron tubes are used commercially for the first time for power control and conversion purposes.

ORGANIZATION

President Swope announces an income adjustment plan for the stabilization of earnings in accordance with the Department of Labor cost-of-living figures.

Walt Disney with GE recording spectrophotometer.



Juice-o-Mat (r.); Hotpoint automatic roaster (top center); Toaster, "A-la-carte" table cooker and Dorchester coffee maker (bottom center); Portable mixer (l.).

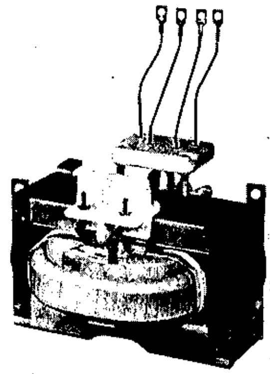
New Small Appliances for the Kitchen

1937

POWER GENERATION AND DISTRIBUTION

The first hydrogen-cooled turbogenerator built for commercial service is constructed for the Dayton Power and Light Company. This 3600-rpm generator is rated at 31,250 kva.

New "Spirakore" distribution transformers are designed with machine-wound steel ribbon replacing hand assembled laminations.



"Spirakore" distribution transformer, internal structure.

APPLIANCES

A new assembly line for the large scale production of electric washing machines is placed in operation at Bridgeport, Connecticut.

A high-sensitivity photo exposure meter is marketed by GE. Combined with photoflash bulbs introduced a few years earlier, it makes possible significant improvements in home and professional photography.

TRANSPORTATION

Over a mile of continuous rail track is formed by flash welding the ends of rails. This joint development of the Delaware and Hudson Railway, Sperry Products, Inc. and GE portends smoother, safer riding and fewer maintenance problems.

Howard Hughes sets a transcontinental air record of 7 hours, 28 minutes, 25 seconds. The GE supercharger helps make this historic flight possible.

The GG-I for the record-breaking Pennsylvania Railroad electrification.

ELECTRONICS

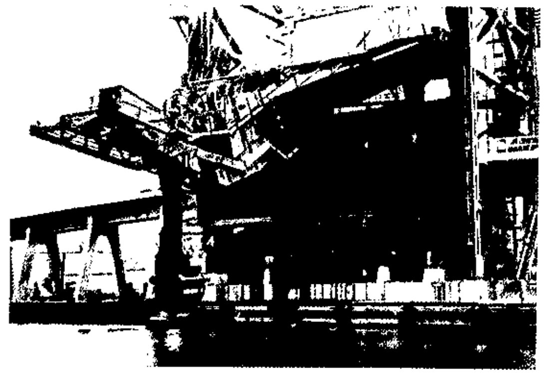
The first AC network analyzer is built to simulate electric utility power systems and will provide a speedy measurement method of power flow analysis in place of the old longhand calculations.

MATERIALS

A.W. Hull and others at the Research Laboratory develop Fernichrome and Fernico alloys for glass to metal seals used in vacuum tube constructions. Because the coefficients of expansions of the alloys are close to those of the glasses used, strains at the points of sealing are eliminated, and the dangers of seal failure are greatly reduced.

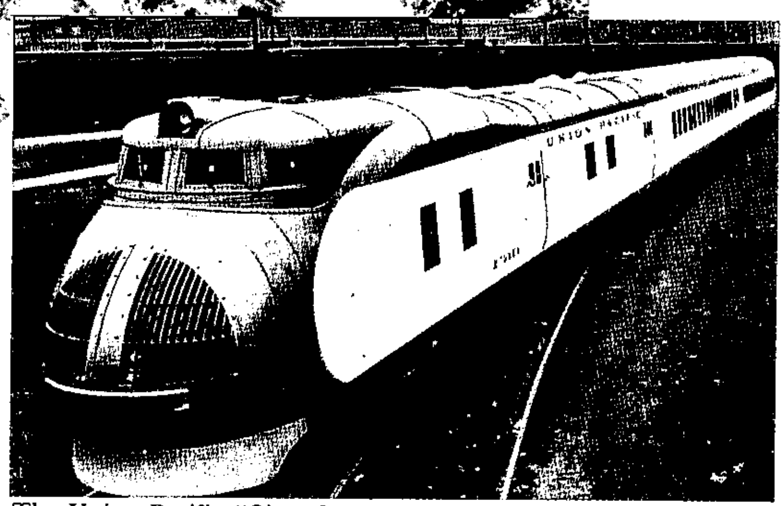
INDUSTRIAL EQUIPMENT

A GE-powered "lift and turnover" car dumper placed in service on Lake Superior can pick up a 95-ton car and empty its contents into the hold of an ore carrier in a minute.



95-ton electric car dumper on the Great Lakes.

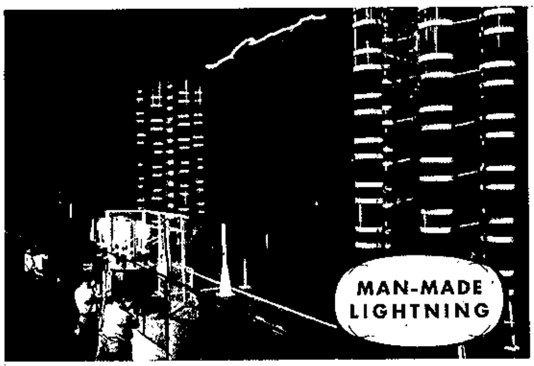
Chicago, Burlington and Quincy "Zephyr" diesel-electric locomotive.



The Union Pacific "City of Los Angeles" diesel-electric locomotive.

THE STREAMLINERS ARE HERE!

1938



Ten-million-volt man-made lightning at the New York World's Fair.

TRANSPORTATION

A record 20,000 feet is reached by a U.S. Army Air Corps stratosphere plane which has the first supercharged cabin in the United States. GE superchargers make it possible to maintain cabin pressure and temperature at high altitudes. New controls for fully feathering plane propellers in seconds are introduced by GE.

POWER GENERATION AND DISTRIBUTION

The Pittsfield High Voltage Laboratory produces record 10,000,000 volt artificial lighting at the New York World's Fair.

LIGHTING

General Electric announces the commercial availability of fluorescent lamps. The production lines for the 15-watt, 20-watt and 30-watt units were developed by a group led by P.J. Pritchard. New phosphors for brightness and daylight color are developed by Willard Roberts of Nela Park and by Gorton Fonda and others at the Research Laboratory.

Hot-cathode mercury-vapor germicidal lamps are marketed by the Lamp Department. Because of their ability to produce ultraviolet radiation effective in destroying air-borne bacteria, the lamps are used in hospitals, nurseries and other public areas.

Fluorescent lighting on display at the New York World's Fair.

INDUSTRIAL EQUIPMENT

The Company's 19,000,000th meter is completed at the West Lynn Works as the 85th birthday of the late Elihu Thomson was being observed.

COMMUNICATIONS

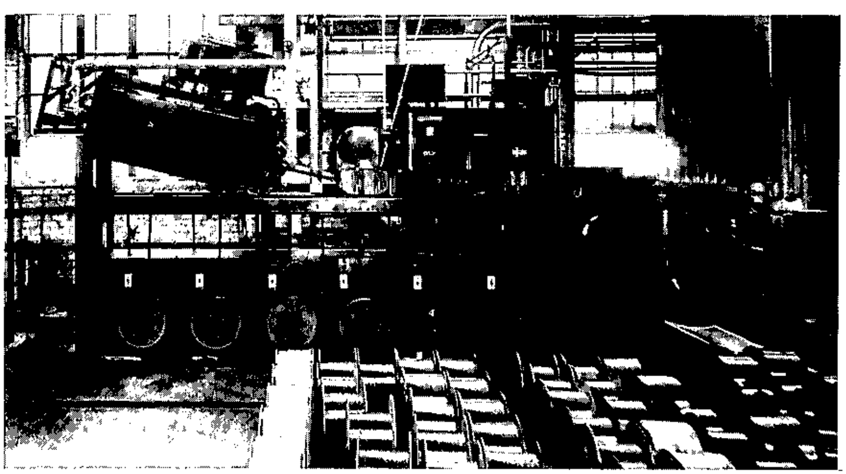
WGY moves into a new home that contains the latest in studio and control-room equipment. The new building boasts five studios, including one two stories in height and equipped with a balcony for spectators.

A new television studio is opened in Building 36, Schenectady, to house GE experimental TV Station W2XB, (later to become WRGB).

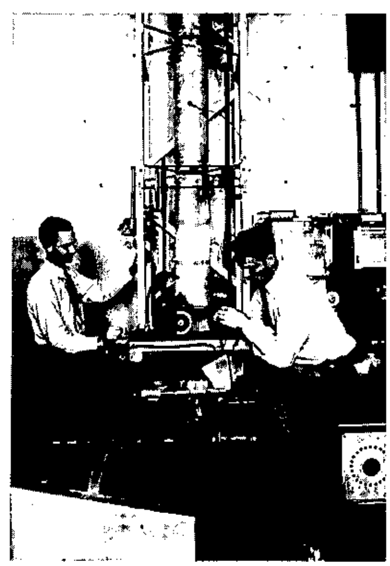
New GE television studio in Schenectady.

MATERIALS

Formex wire enamel developed by Winton I. Patnode, A.L. Marshall and others in the Chemistry Section of the Research Laboratory is introduced for use in electric motors. The ability of the enamel to form an exceptionally tough and adherent wire coating with superior electrical properties and resistance to solvents and high temperatures makes possible significant reductions in motor size and further improvements in motor performance.



Formex wire enameling equipment at GE's Lynn River Works.



Winton I. Patnode of the Research Laboratory and Edward J. Flynn of the General Engineering Laboratory working with an experimental tower used in Formex wire enamel studies.

1939

Charles E. Wilson

LIGHTING

The all-glass, sealed-beam headlight is developed for the automotive industry. Each hermetically sealed lamp is a complete headlight unit with lens and aluminized reflector.

ORGANIZATION

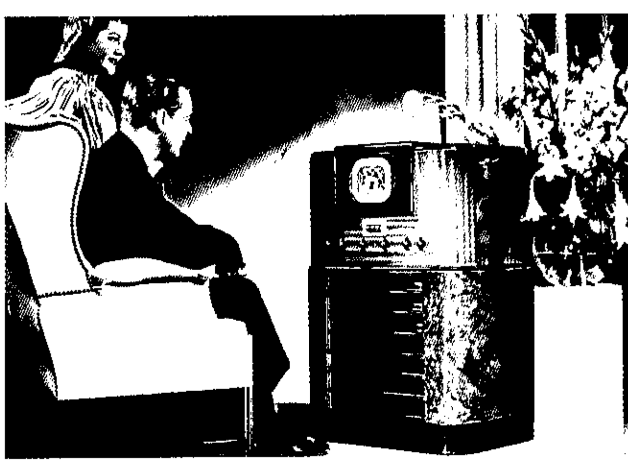
Board Chairman Owen D. Young and President Gerard Swope asked for retirement; Philip D. Reed and Charles E. Wilson are elected to succeed them, respectively, as of January 1, 1940.

The GE Vapor Lamp Company merges with the Incandescent Lamp Department to form the Lamp Deprtment of the General Electric Company.

Philip D. Reed

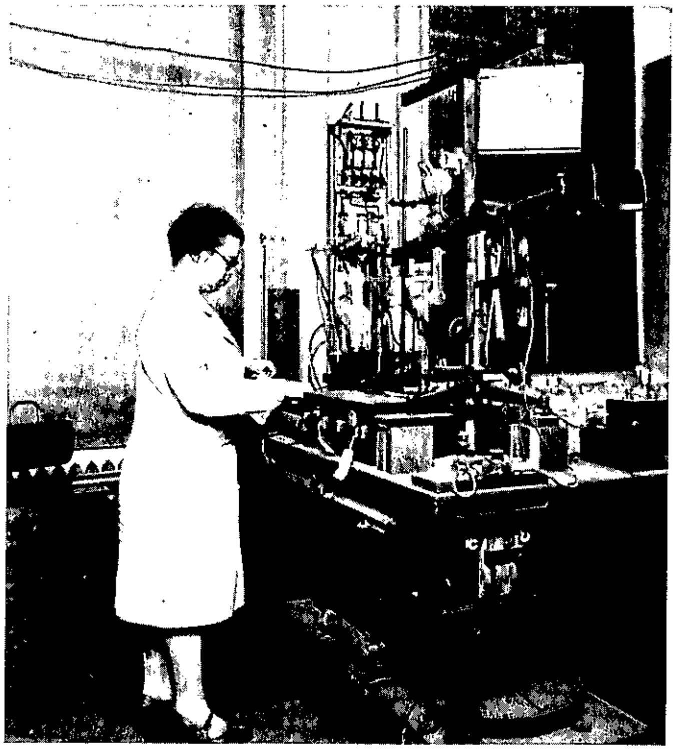
COMMUNICATIONS AND ELECTRONICS

General Electric broadcasts television programs from the New York World's Fair. The Radio and Television Department is formed; and the first lines of TV and FM receivers are announced.



New GE console television receiver, HM-225.

New AM-FM radio.



Katharine B. Blodgett in her laboratory in 1929.

MATERIALS

Katharine B. Blodgett of the Research Laboratory develops "glareless glass" using a process of depositing single layers of molecules on the surface of the glass, rendering it non-reflective.

TRANSPORTATION

A GE turbo-charged P-38 makes an unofficial cross country record of 7 hours, 20 minutes. Over Pittsburgh, the pilot radios his 22,000 ft. altitude and 420 mph speed.

The highest cog railway in the world, up Pike's peak and its partial 25 degree grade, switches from steam to diesel-electric. GE builds its first rack-rail diesel-electric locomotive which pushes, rather than hauls, a 50-passenger sight-seeing car 14,109 feet to the peak.

Katharine B. Blodgett

Known widely as a woman who invented "invisible glass," Katharine Burr Blodgett was the first woman scientist to join the General Electric Research Laboratory. This she did in 1918 after receiving a B.A. degree in physics from Bryn Mawr and an M.S. from the University of Chicago.

Assigned to Irving Langmuir's staff, she assisted him in his experimental research and collaborated with him in writing technical papers reviewing their work. Early in his long, productive association with her, Langmuir observed, "Katharine is a gifted mathematician, who has that rare combination of theoretical knowledge and practical ability."

In 1924 she took a leave of absence to become one of the few women students at the Cavendish Laboratory of Cambridge University in England. Two years later, she received the first Ph.D. degree in physics ever awarded to a woman by the university. Her worktable in Langmuir's laboratory was waiting for her when she returned, and she became the first woman Ph.D. on the staff.

In 1938 her invention of nonreflecting, "invisible" glass received widespread public recognition, and it became the prototype of coatings used today on virtually all camera lenses and optical devices. However, this was only a by-product of her long-time research in surface phenomena and her development of methods of depositing films of minuscule and precisely controlled thickness.

During World War II the efficiency of submarine periscopes and aerial cameras was increased immeasurably by the use of coatings that she developed. She also tackled the problem of ridding airplane wings of ice and helped devise a faster, denser smoke screen than that provided by the simple smudge pots in use at the time.

Katharine Blodgett's attitude toward her career was best described in her own words during an interview over GE radio station WGY. She declared, "Each year I learn some new ways to make life in the laboratory more fun, and wonder why I never learned them before. They consist mostly in tackling the problems to which I used to say, 'I can't,' and I usually find that they are not so difficult as I thought they would be."

PIONEERING IN ELECTRONICS

Albert Wallace Hull
1880-1966

Albert W. Hull

A genuine Connecticut Yankee, Albert Wallace Hull was born in Southington, Conn., on April 19, 1880. He was the second oldest of eight boys. Science seems to have held an appeal for the family, for five chose technical careers: physics, bacteriology, metallurgy, forestry and engineering. All five went to Yale.

He chose physics for a profession and never regretted it. Perhaps this experience accounts for the advice which he invariably gave young men, that it is more important to find the right job than to get a high salary. Receiving a Ph.D. from Yale in 1909, he taught at Worcester Polytechnic Institute before Langmuir and Coolidge discovered him and invited him to the General Electric Research Laboratory for the summer of 1913. This taste of industrial research proved infectious; after finishing out the year of teaching, he returned to Schenectady, never to leave. In 1928, he became assistant director of the Research Laboratory.

Alert, scholarly, incisive, Hull was the creator of a greater number of new types of electron tubes than any other man, and an important contributor to the fundamentals of physical science as well.

His first work at the laboratory was on electron tubes, X-ray crystallography and piezoelectricity. After World War I, he published a classic paper on the effect of uniform magnetic fields on the motion of electrons between coaxial cylinders. During the 1920s, he studied noise in diodes and triodes, which led to the development of the tetrode, or screen grid tube, thus eliminating the ion bombardment of the cathodes. During this same period, he invented the thyratron, a gas-filled electron tube that found application in the control of medium powered devices and led the way to a new branch of technology, industrial electronics.

During the 1930s, he directed his research to metallurgy and glass science, which led to the development of new alloys such as Fernico.

Albert Hull's industrial scientific work with General Electric has had tremendous scientific and practical consequences. Together with Coolidge's work on tungsten and Langmuir's work on high vacuum electronic phenomena, he was one of the pioneers who provided the foundation for the electronics businesses of General Electric.

He retired from GE in 1950 but remained professionally active for many years after. His last publication, in 1966, came fifty-seven years after his first.

Many honors came to Hull: the Howard N. Potts Medal of the Franklin Institute, given in 1923 for work on X-ray crystal analysis; the Morris Liebmann prize of the Institute of Radio Engineers in 1930 for his work on vacuum tubes; membership in the National Academy of Sciences; and presidency of the American Physical Society.

It is difficult to summarize a great career like Albert Hull's, but of all his many accomplishments, two outstanding characteristics seem to have provided the essence of his success. First and foremost was his great courage and optimism, which opened doors that were closed to many people. The second characteristic was his willingness to enter a brand new field. He was constantly challenged by new problems, and he had the courage to become a neophyte in a new field where his native abilities soon brought him again to the top as an expert and an authority.

Walter Ransom Gail Baker
1892-1961

W.R.G. Baker

"When the history of the first century of the electronics' age is written, the name of one man will stand preeminent on its pages. That man is Walter R.G. Baker. No other man in the field of electronics today combines so many talents and has applied them with such benefits to the profession and industry." So said Donald G. Fink, President of IRE in presenting the Institute of Radio Engineers Founders' Award to Baker in March, 1958.

A graduate of Union College, Schenectady, N.Y., from which he received three degrees, Baker joined the GE General Engineering Laboratory in 1917. The following year, his work with new vacuum-tube transmitters and receivers for the Army and Navy included development and testing of radio apparatus for aircraft, submarines, captive balloons, torpedo boats, destroyers, and battleships. As work in this field increased, a separate Radio Department was established, and Baker was made design engineer in charge of transmitters.

In 1924 his responsibility was enlarged to include the design of all radio products, and in 1926 he was given complete charge of development, design and production. On the formation of the RCA-Victor Corporation in 1929, he went to Camden, N.J., to head the radio engineering activities of the new organization. Within the year, he was placed in charge of production and later became general manager of the RCA-Victor plant. In 1935 GE transferred its radio receiver activities to Bridgeport, and there Baker resumed his connections with the Company. He was named managing engineer in 1936 and, in 1938, became manager of the new Radio and Television Department. His work with Major E.H. Armstrong in the further development of frequency-modulation transmission resulted in the widespread use of FM broadcasting and the production of a whole new line of radio receivers providing sound fidelity previously unattainable. In 1941, he was elected vice president by the Board of Directors.

Says Dudley Chambers, one of Baker's close associates, "Doc was an inveterate worker, traveling and working all the time. What's more, he had a knack for getting people together. An example of this was the organization and direction of two national committees which recommended engineering standards to the FCC, thus paving the way for commercial monochrome telecasting in 1941 and color TV in 1953 — a major contribution to the electronics industry."

When Baker retired from GE in 1956 he launched upon a new career. He was appointed vice president of Syracuse University, with responsibilities for the contract research program. Soon afterward, he became president of the Universities Research Corporation, a position he held until his death in 1961.

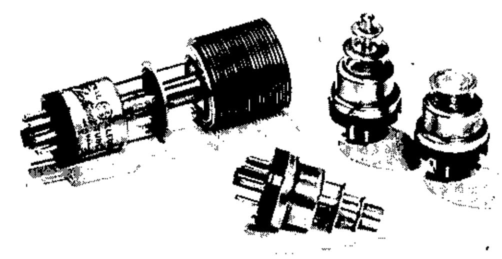
W.R.G. Baker viewing laboratory-built TV receiver.

1940

COMMUNICATIONS AND ELECTRONICS

The disk-seal tube, later known as the "lighthouse" tube, is announced. The use of plane electrodes permits closer electrode spacing and operation at 200 megacycles. It is expected that future designs will operate at 3000 megacycles.

GE's television station WRGB becomes the first to relay television broadcasts from New York City. This relay marks the formation of the first television network.



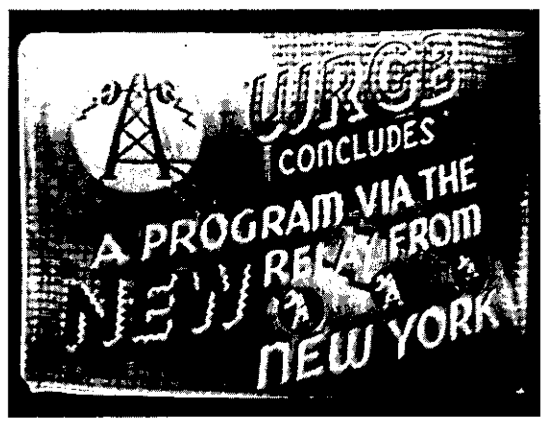
"Lighthouse" transmitting and receiving tubes.

APPLIANCES

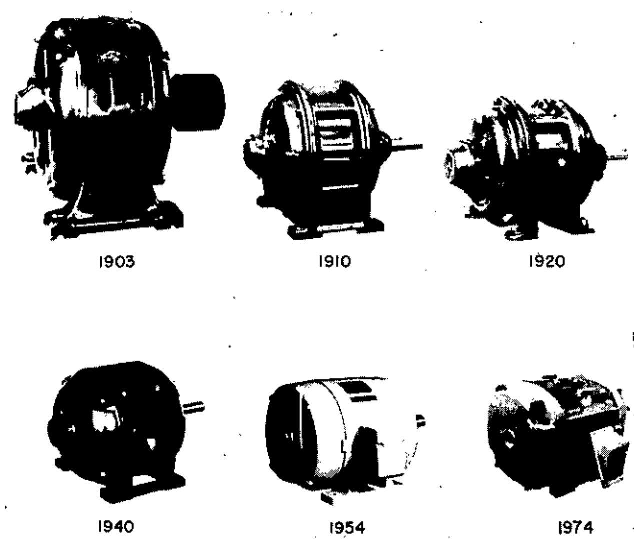
Window-mounted air conditioners are introduced for home use.

INDUSTRIAL EQUIPMENT

A gas turbine is installed to operate an air compressor at a Union Oil Company refinery at Oleum, California. It is powered by 1000°F gas obtained as one of the refinery's products of combustion. Numerous other industrial compressors are manufactured using the centrifugal flow design originated by Sanford Moss.



A new line of small, integral horsepower polyphase and single phase motors called "Tri-Clad" is introduced. These motors have improved protection and insulation as well as streamlined appearance. Very soon, all induction motors from 1 hp to 1000 hp will have similar construction and appearance.



A pictorial review of progress in motor design over the years.

Eugene George Rochow

It was fortunate for the silicone industry (and GE) that Eugene G. Rochow began the General Electric silicone project in 1938. His personal qualities and his scientific abilities, his career at Cornell, and his early experience in the Company all made it virtually certain that he would do successful applied research on silicones if such success was in the cards.

H.A. Liebhafsky:
SILICONES UNDER THE MONOGRAM

The silicone project was an outstanding success, and what's more, it led to the founding of a major industry.

When Rochow came to the Research Laboratory in 1935, he was well schooled at Cornell University, receiving a B.A. in 1931 and a Ph.D. in 1935. His graduate work involved research in organometallic chemistry, and this was soon to stand him in good stead.

MATERIALS

Kenneth H. Kingdon and Herbert C. Pollock of the Research Laboratory, using a mass spectrometer of their own construction, isolate a very small quantity of the rare form of uranium known as "U-235."

Eugene G. Rochow of the Research Laboratory devises the "direct process" for making chlorosilanes, the compounds from which silicones can be produced. The process eliminates much of the hazardous nature and inefficiencies of alternate methods of preparation.

William F. Gilliam, Winton I. Patnode and others under the direction of A.L. Marshall collaborate with Rochow in other silicone related developments leading to a family of materials that can be produced in many forms for superior flexibility, resistance to oxidation and good dielectric properties.

POWER GENERATION AND DISTRIBUTION

The number of electrified farms in the United States reaches an estimated 2,000,000. There are about two hundred uses of electricity on the average farm.

Pittsfield builds its heaviest transformer to date, a 491, 000-lb, 66,667-kva, unit for the Central New York Power Corporation.

His first assignment was with the ceramics group, under the direction of Louis Navias. His task was to improve the electrical properties of fused magnesium oxide used in all Calrod® heating units manufactured at the Pittsfield Plant and at Hotpoint in Chicago. When the program was well on its way to a successful conclusion, A.L. Marshall encouraged him to experiment with organic compounds containing silicon.

At that time, there was need for higher temperature capability resins and several laboratories were working hard to develop them. The only method known then to couple a silicon atom to a carbon atom was by means of a Grignard reagent involving magnesium. So, Rochow first tried to make the Grignard reagent approach simpler, more efficient, and less expensive. Other researchers elsewhere tried it also, with no commercial success.

Rochow's inspirational solution was to use elemental silicon with various organic compounds, and copper as a catalyst, reacting at about 300°C. This process became the forerunner of many desirable new materials. A whole group of chemists, and finally chemical engineers, entered the field. They developed a pilot plant, and then under the direction of Charles E. Reed, a large-scale production facility was put on stream at Waterford, N.Y., in 1947. Among the great variety of products now made there are silicone resins, greases, liquids, and elastomers.

For his pioneering work in this field, he received several prestigious awards and honors, including the Baekeland Medal in 1949, the Matiello Award in 1958, the Perkin Medal in 1962, the Kipping Award in 1965, and the Norris Award in 1974.

In 1948, he became associate professor of chemistry at Harvard University, and full professor from 1952 until retirement in 1970. Until well into 1974, he acted as consultant to GE's Silicone Products Department.

PIONEERING IN MAN-MADE MATERIALS

Abraham Lincoln Marshall
1896-1974

Abraham Lincoln Marshall

During his 35-year GE career, Abe Marshall led pioneering efforts resulting in a variety of man-made materials that became the basis for important new directions of the Company's growth.

Born in Victoria, British Columbia, Marshall completed his undergraduate degree in chemistry at the University of British Columbia in 1918 and received the Ph.D. degree in physical chemistry from the University of London in 1922. While serving as an instructor at Princeton, he spent two summers at the General Electric Research Laboratory, and accepted a full-time position there in 1926.

As a research associate, he continued his earlier work in photochemistry and also performed fundamental investigations that contributed to a better understanding of the "bake-out" step required in the manufacture of vacuum tubes. His brilliance and administrative potential were recognized by William D. Coolidge who, in 1932, succeeded Willis R. Whitney as Director of the Research Laboratory. In 1933, Marshall became head of the Insulation Section, a group that soon incorporated other activities as it evolved first into the Chemical Section, and later, in 1950, into the Chemistry Research Department.

In describing Marshall's contributions, Arthur M. Bueche, now Senior Vice President for Corporate Technology, said,

> *"Abe was one of the true giants of chemistry during a period when chemical research revolutionized many industrial processes and made possible new products of broad benefit to mankind."*

The superior properties of Formex® and Alkanex® wire enamels and Flamenol®, Irrathene® and Vulkene® cable insulations resulted in improvements in the design and performance of motors, transformers, and a variety of other equipment produced by the electrical industry.

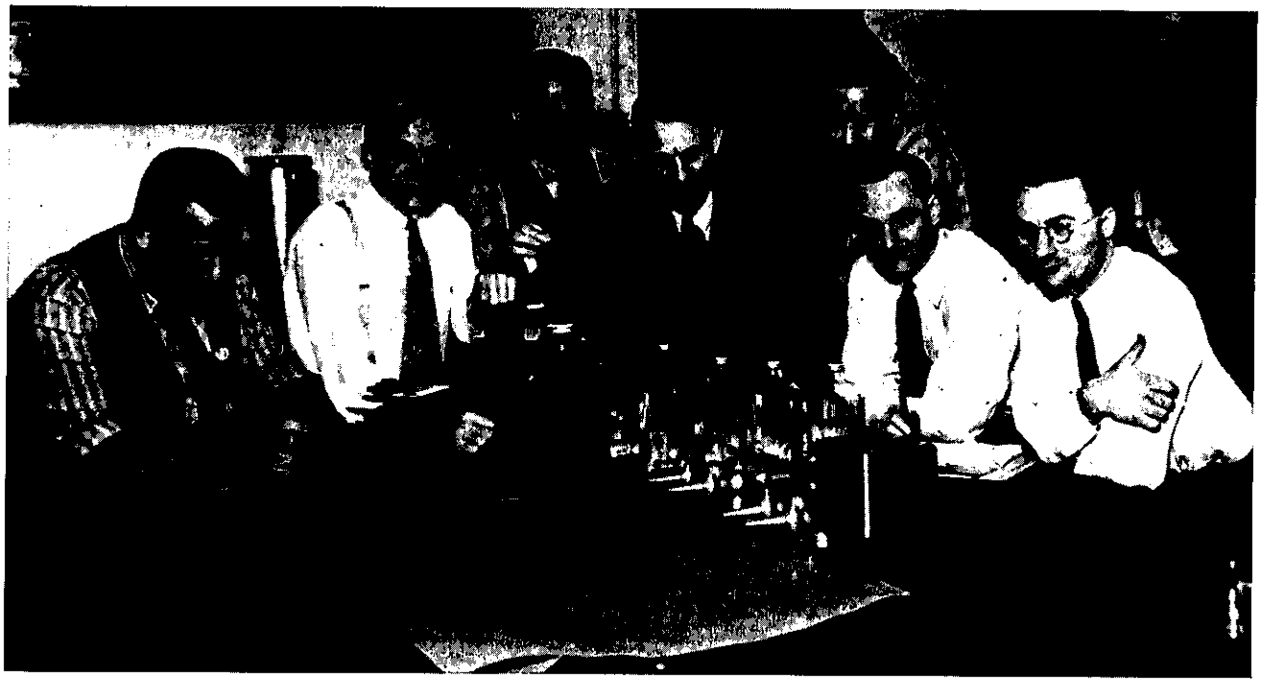
The Laboratory's basic studies of polymers for high temperature applications led to the development of a "direct process" method by which virtually all silicones are produced today. It is the key to commercial production of a host of silicone-based products manufactured by GE's Silicone Products Department.

Lexan® polycarbonate, PPO® polyphenylene oxide and Noryl® thermoplastic resins were representative of new classes of engineering plastics that became major Company businesses.

Scientists and engineers under Marshall's direction announced, in 1955, the invention of the first reproducible process for making diamonds. This process became the basis for GE's Man-Made™ industrial diamond business, which is today one of the world's major sources of industrial diamond abrasives.

Known as the "Dean" of General Electric chemistry, Abe Marshall saw the number of chemists and chemical engineers throughout the Company grow from approximately 400 to 2700 during the years he headed chemistry research at the Research Laboratory. A member of the American Chemical Society since 1918, he was active in that organization as a member or chairman of several executive committees. He also served as a member of the management committee and the advisory board of the Gordon Research Conferences.

The stimulating intellectual environment that he fostered and the sound business judgment he exercised were key sources of support for the many talented people who worked for and were inspired by him.



The silicone research team: from left, William J. Scheiber, Eugene Rochow, Robert O. Sauer, Abe Marshall, W.F. Gilliam, Winton I. Patnode and Murray Sprung.

Maynard Agens processing silicone rubber compositions.

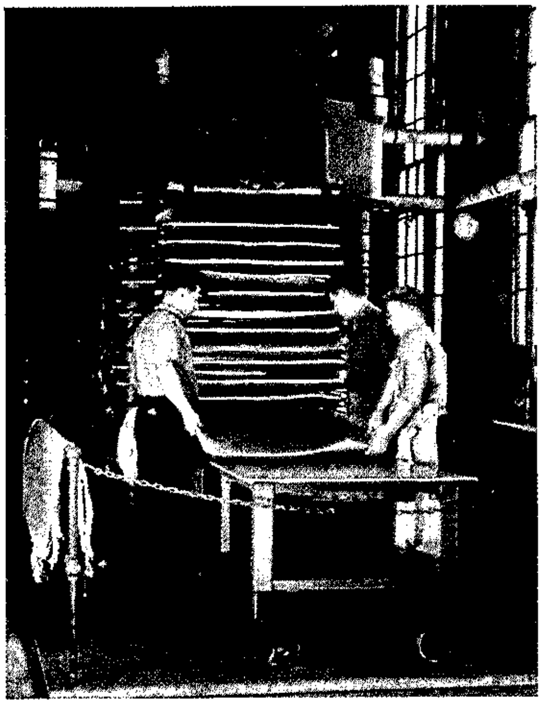
Abe Marshall working in his laboratory in 1928.

1941

LIGHTING

"Black light" lamps are placed in production. The ultraviolet radiation produced by these low luminosity lamps can activate fluorescent materials, causing them to glow brightly.

George Inman is granted a U.S. patent for the basic principles of fluorescent lamp design. (see 1936)



Producing Textolite sheet for a variety of industrial uses.

MATERIALS

It is announced that General Electric is the largest producer of finished plastics in the United States.

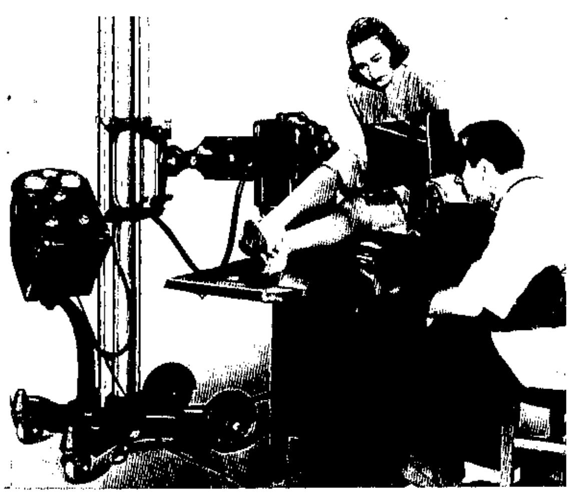
TRANSPORTATION

GE-designed turbosuperchargers for aircraft engines are manufactured at its plants at Ft. Wayne, Indiana, and Everett and Lynn, Massachusetts. From 1925 through this wartime period, GE has been practically the sole supplier of impellers for all of the Wright and Pratt and Whitney engines.

The new battleship "North Carolina," the largest U.S. warship, is launched; equipped with GE propulsion, she is expected to develop 115,000 hp and have a speed of more than 27 knots.

INDUSTRIAL EQUIPMENT

GE installs a 1,400,000-volt industrial inspection X-ray machine for the U.S. Bureau of Standards. By using a gaseous insulating medium in place of oil, a sizable reduction in the physical size and weight of the unit is accomplished. Similar high-voltage X-ray machines are used for treatment of deep-seated cancers.



Mobile X-ray unit for medical use.

Million-volt X-ray unit for inspecting castings.

PIONEERING IN AVIATION

Sanford A. Moss
1872-1946

Sanford A. Moss

At the age of 16, while employed as a $4 per week mechanic in a shop that produced compressed air machinery, Sanford Moss had an idea: that if fuel could be burned in compressed air, the energy output would be increased tremendously. This idea, which was to make possible the altitudes, the speed and range of today's aircraft, came years before the Wright Brothers made their historic flight at Kitty Hawk.

Moss took the idea with him to the University of California. By 1900 he had earned his Bachelor's and Master's degrees, and he went on to Cornell where, in 1903, he wrote his Ph.D. thesis on the gas turbine. The thesis attracted the interest of engineers at GE and got him a job at the West Lynn plant. Working with Charles Steinmetz and Elihu Thomson, Moss first concentrated on centrifugal compressors used in blast furnaces and then on steam turbine development. The experience he gained in these fields was recognized during the first World War by the National Advisory Committee for Aeronautics, which asked him to find a way to give military planes more power. Moss's solution, worked out with the cooperation of the U.S. Air Corps, was the turbocharger — a unique turbine-type compressor.

On June 19, 1918, Moss and his associates ascended Pikes Peak with a 350-horsepower Liberty engine in tow in order to test his turbosupercharger. The new device attached to the reciprocating engine was designed to boost power by compressing air into the intake, allowing the engine to "breathe" normally even in the thin air at 14,019 feet. His turbosupercharger was a success. In 1921, a new world altitude record of 40,800 feet was established in a biplane equipped with the device.

Interest in it extended even to the automobile racing circuits, where at least one Indianapolis 500 winning car was fitted with a Moss turbosupercharger. During most of the period between World War I and World War II, while at GE's Lynn Works, Moss also developed the geared supercharger using design principles that have since been followed on most radial-type airplane engines.

Although over 65 years of age, he returned voluntarily to GE at the outbreak of World War II and went to work refining the turbosupercharger. When the United States entered the war, he became consultant to the Army Air Forces. Soon, the B-17 Flying Fortresses, the B-24 Liberators, the P-47 Thunderbolts, and, later, the B-29 Superfortresses, all equipped with turbosuperchargers, were flying higher, faster, and farther than planes had ever flown, including those of the enemy.

As for the industrial gas turbine, it waited until after World War II when GE engineers combined metallurgical developments with new jet engine technologies to turn Moss's dream of some 40 years earlier into reality.

Moss's technical contributions were also evident in areas outside of the hardware used in airplanes, automobiles and industrial equipment. He will be remembered for the militant enthusiasm and energy with which he advanced the standardization of symbols and terms used internationally in science and engineering. In this and in other pursuits, it was said of him that he had "a bit of the maddening quality of the devil, blended with the evangelical fanaticism of the crusader." His zeal bore fruit. As a result of his pioneering efforts, Moss received the Collier Aviation Trophy in 1941, the Sylvanus Albert Reed Award of the Institute of the Aeronautical Sciences, the A.S.M.E. Holley Medal and the Howard N. Potts Medal of the Franklin Institute.

1942

MATERIALS

To meet wartime needs, GE plants manufacture 400 different plastic parts for aircraft, demonstrating some of the most important engineering applications of plastics to date.

TRANSPORTATION

The first successful American jet aircraft undergoes its initial flight tests on October 2. The plane is the Bell XP-59 Airacomet, and is powered by two GE I-A turbojets, each rated at 1250-lb thrust. Designed at Lynn, Mass., and using a centrifugal compressor, this model is soon uprated to 1600-lb thrust and designated the I-16, becoming the first production jet engine in the United States.

ELECTRONICS AND COMMUNICATIONS

GE's first electron microscope is designed and constructed at the General Engineering Laboratory. The microscope magnifies ten times better than the best light microscopes.

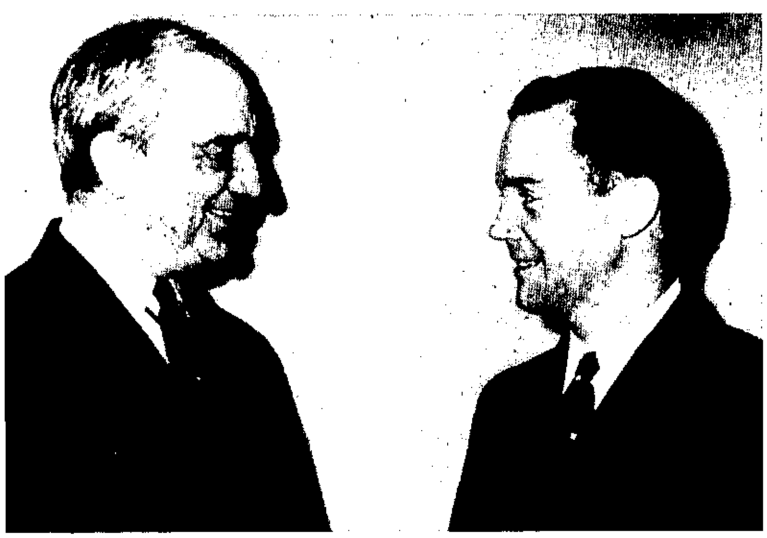
TV station WRGB at Schenectady becomes the second station in the country to receive an FCC commercial license.

The first GE Ordnance gun directors, manufactured for the U.S. Navy, are shipped from the newly completed facility at Pittsfield, Mass.

ORGANIZATION

Charles E. Wilson resigns to become a member of the War Production Board; Gerard Swope comes out of retirement to serve as President of General Electric.

Philip D. Reed resigns to help administer the Lend-Lease Program and later becomes Chief of the United States Mission for Economic Affairs in London, with the rank of Minister; Owen D. Young returns as Chairman of the Board.

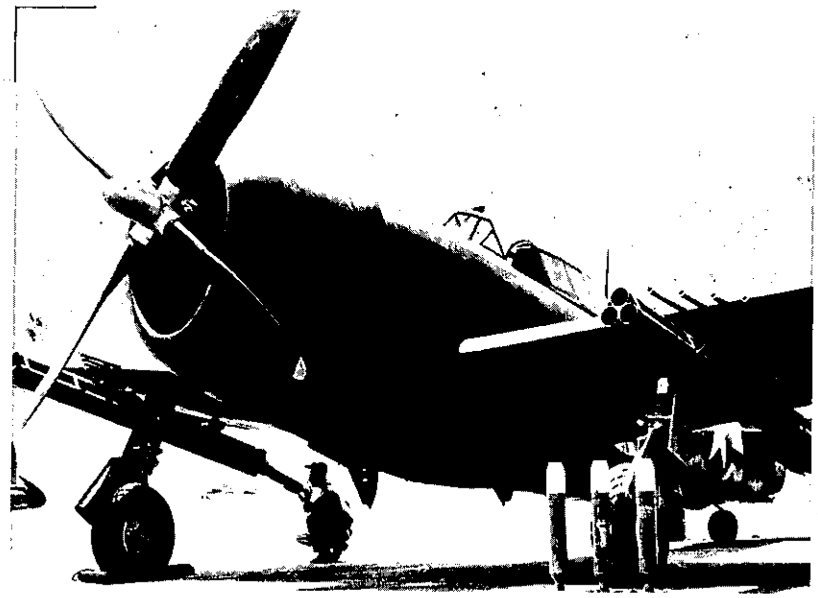


Owen D. Young (l.) with Philip D. Reed, then Chief of United States Mission for Economic Affairs in London

Cooling molten phenolic resin.

From Resin

to Rocket Launcher



Loading projectiles into P-47 rocket launchers, built by GE of paper and plastic composition.

From left to right: S. Ramo, W.C. White and C.H. Bachman and GE Electron Microscope.

THE WAR YEARS
1941-1945

"No single industry has made a quicker response to our appeal for equipment than General Electric."

Frank Knox, Secretary of the Navy

War has always been a grim drama of men and materials. In the early part of World War II, the allies were short of both. But when the productive capacity of American industry was mobilized, that force became irresistible.

Most important was the spirit of the men in the armed forces, but equipment was also essential.

"To the civilian workers, we are forever indebted," said General Eisenhower. "No army or navy was supported so well."

American industry reached a production level three times peacetime capacity. New plants were built and people trained to use new techniques. It was an accomplishment exceeding any similar effort of man.

Every unit of American industry participated. Upon some companies fell an exceptional burden of responsibility.

One such company was General Electric.

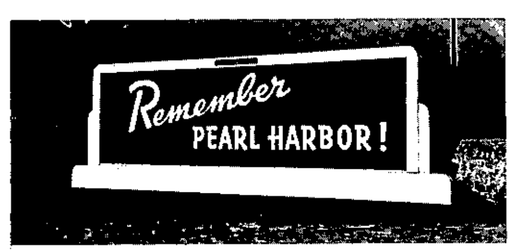
Speaking at the Syracuse Plant, Frank Knox said: "What has been done here could not be duplicated anywhere in the world. So lift your heads with pride because, like our fighting men, you are battling for everything for which America stands."

The partial story of how the largest electrical manufacturer mobilized all the skills and resources for America's war effort on land, at sea, and in the air is depicted here.

General Electric's accomplishment represented the work of more than 175,000 people. It is impossible to mention all to whom credit is due.

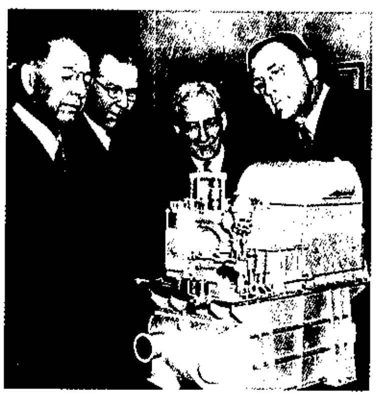
It is probable that General Electric produced a greater variety of complex war equipment, and solved a greater variety of technical problems, than any other manufacturer. It is a story of hard work, long hours, drama, excitement, and romance, a dynamic pattern woven by human hands and brains, fired by enthusiasm and tempered by organization."

From GE President Charles E. Wilson's foreword in *Men and Volts at War* by John A. Miller



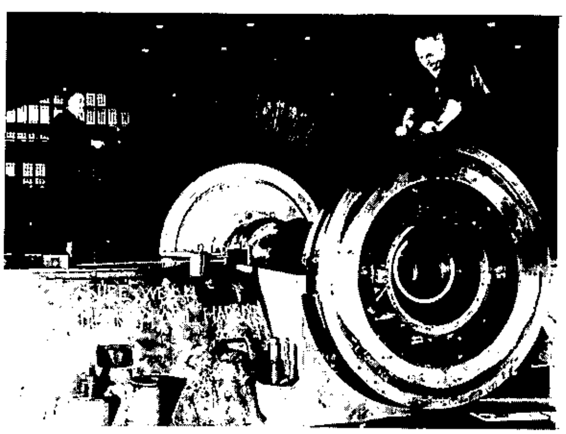
In the Front Office

General Electric's War Projects Committee, which supervised all the company's far-flung war activities, shown here in 1942 reporting to President Charles E. Wilson. Left to right: J.F. Cunningham; Chester H. Lang, chairman; Wilson; J.G. Farrar; and H.A. Winne.

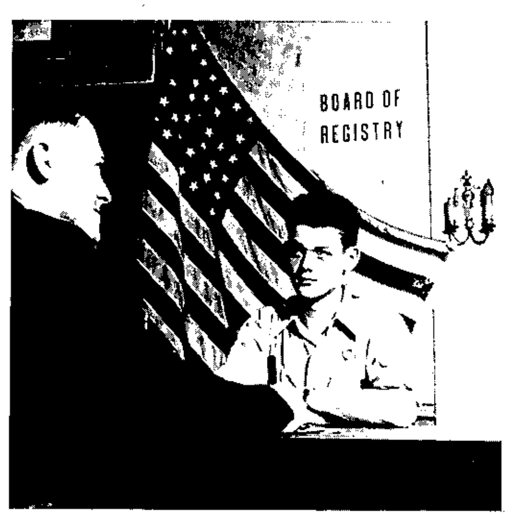


Secretary of the Navy Frank Knox (left) and Charles E. Wilson, Executive Vice Chairman of the U.S. War Production Board, inspecting model of a destroyer escort turbine at Syracuse. In background Gerard Swope, then President of General Electric, and on his right, W.E. Saupe, Superintendent of the Syracuse Plant.

Philip D. Reed (r) with Lt. Gen. Jacob L. Devers (l), Commander of U.S. Forces in Europe at dedication of airfield in England.



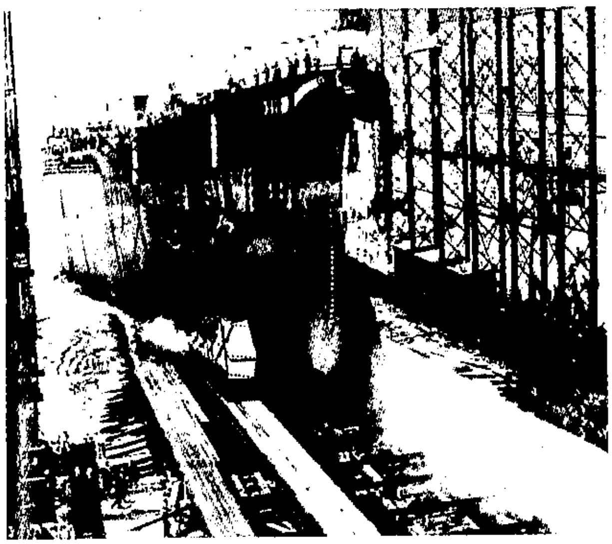
And REMEMBER they did . . . the 175,000 GE people who tackled the war production job that couldn't be done and *did it!*



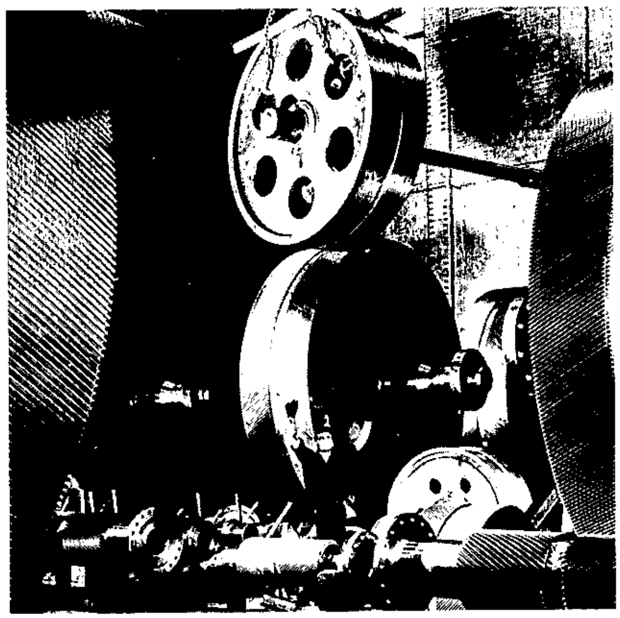
More than 50,000 men and women of General Electric served in the Armed Forces during World War II.

GE at Sea . . .

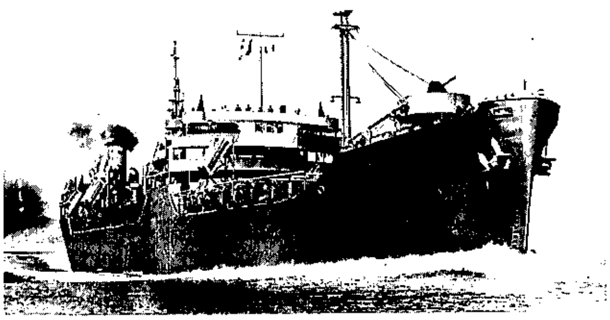
75% of the Navy's ship propulsion and gears were designed and manufactured by General Electric.



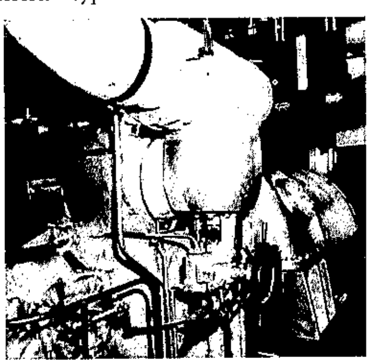
Launching on June 7, 1941, of the GE equipped U.S.S. "South Dakota," which later became widely known as the mysterious "Battleship X."



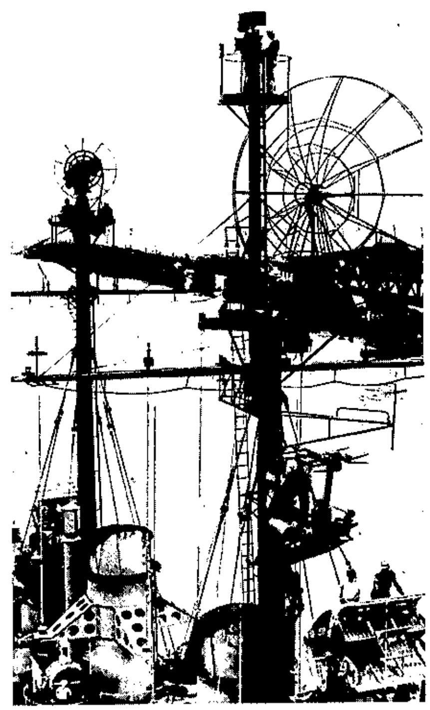
Enormous but precise — gears for ship propulsion as large as 200-inch diameter had to be cut to .003-inch tolerances.



SS "Mission Purisima" — a fast new tanker built during the war. GE supplied turbine-electric drive for 378 ships of this general type.

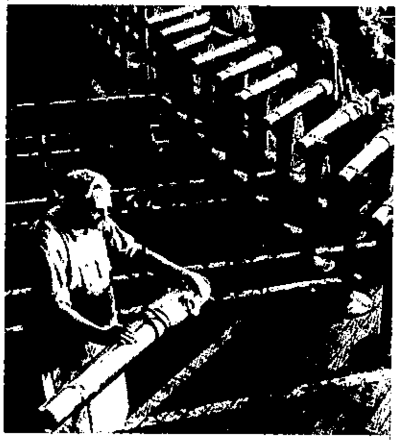


The compact but powerful 10,000-horsepower turbine generator set in the engine room of the SS "Mission Purisima," one of 44 high speed tankers that could travel without escort. Turbine-electric propulsion for the tanker program was built in Schenectady, Lynn, Pittsfield, Philadelphia and Erie.



Aloft on the U.S.S. "Juneau" are a variety of types of air and sea search radar antennas and radar jammers. Before the war was over, GE participated in the design and manufacture of 50 different kinds of radar sets for the armed services.

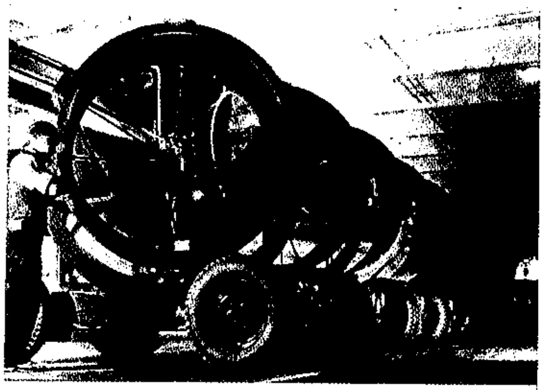
. . . on Land . . .



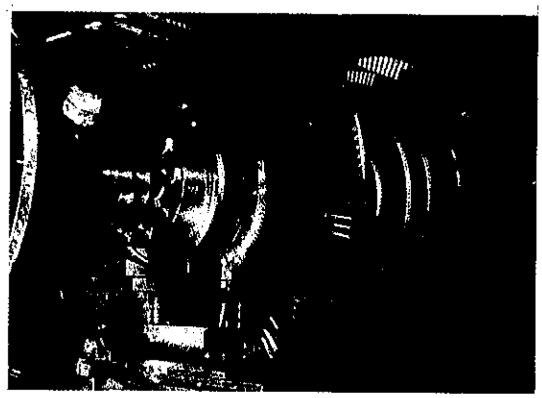
One of the Army's most useful weapons, the 75-mm pack howitzer. Breech mechanisms being finished at Erie.

Making radio transmitters for U.S. Navy at Schenectady. Every type of Navy transmitter above 24 kilowatts was produced by the Company.

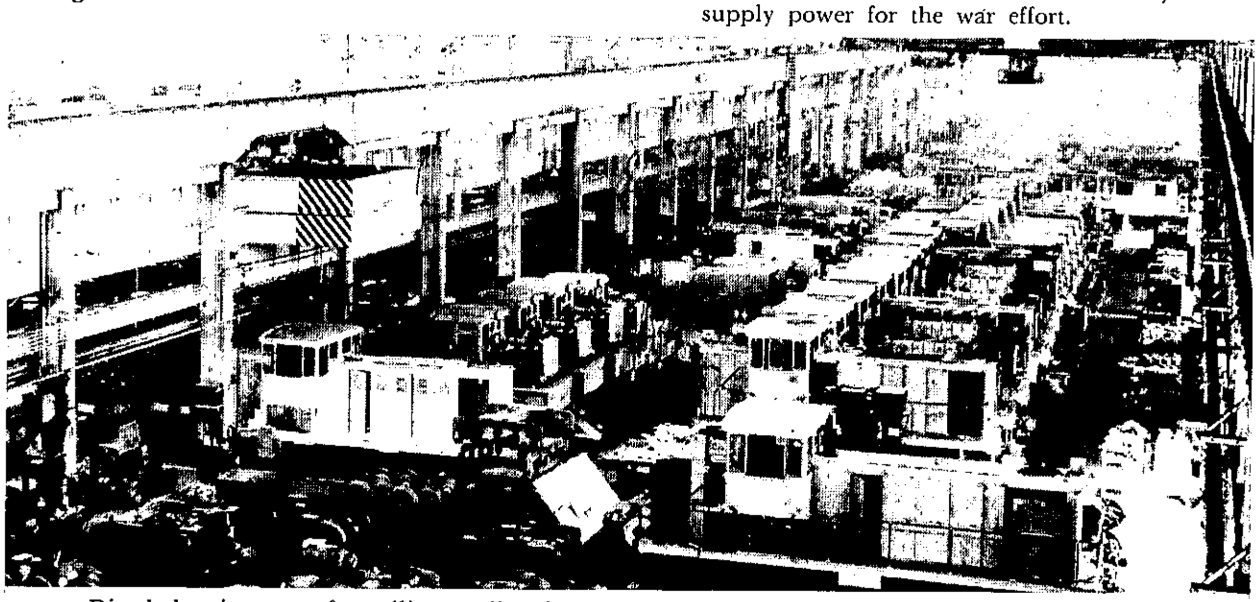
Portable smoke generator of Chemical Warfare Service, principle for which was developed in the GE Research Laboratory.



Checking completed 60-inch antiaircraft searchlights at Erie.



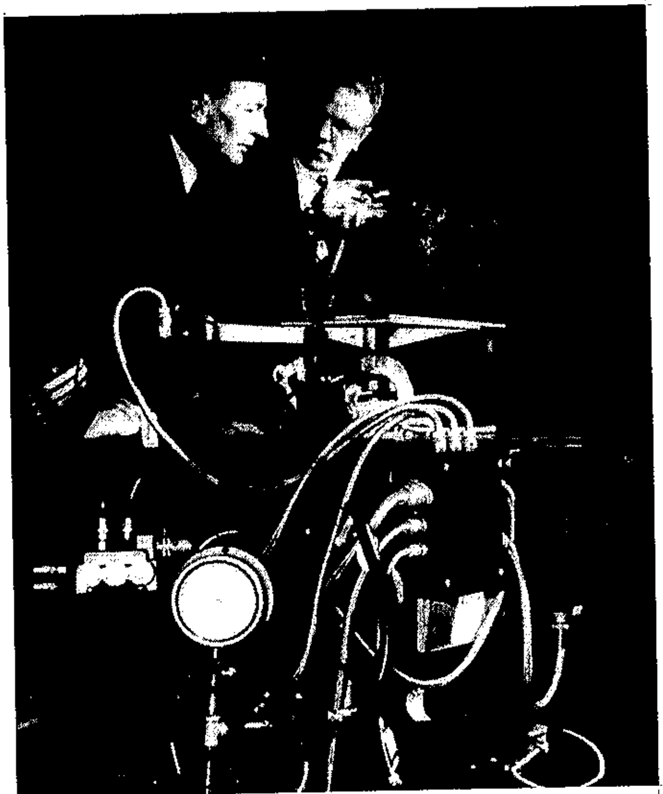
Rotor for one of many big land turbine-generators that GE built in Schenectady to supply power for the war effort.



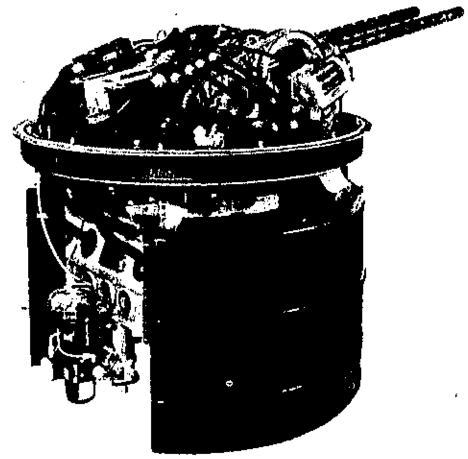
Diesel-electric power for military railroads — locomotives under construction at the Erie Works.

. . . and in the Air

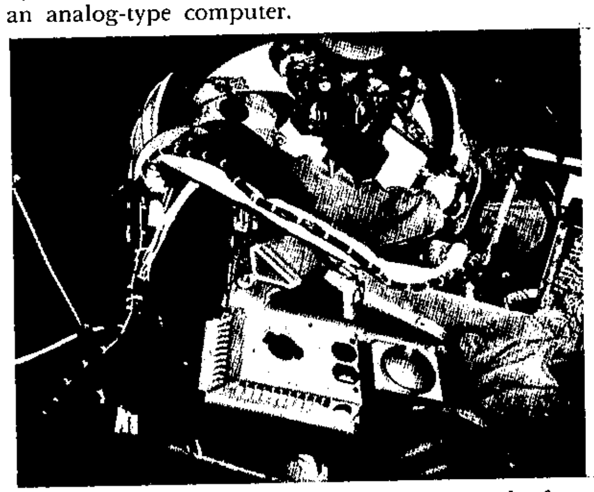
The Aeronautics Ordnance and Marine Division, the Electronics Division, the Aircraft Jet Engine Division and the Federal Marine Division led the Company effort. Engineers and scientists in the General Engineering Laboratory and the Research Laboratory solved complex system problems.



Automatic pilot — a GE first — to keep a plane continuously on predetermined course, being inspected by Capt. J.S. Evans, Inspector of Naval Material, and Charles Young, A&OS engineer.



Two-gun aircraft turret designed for power operation by remote control. The B-29 armament system used an analog-type computer.



Rear sighting position for remote control of turrets.

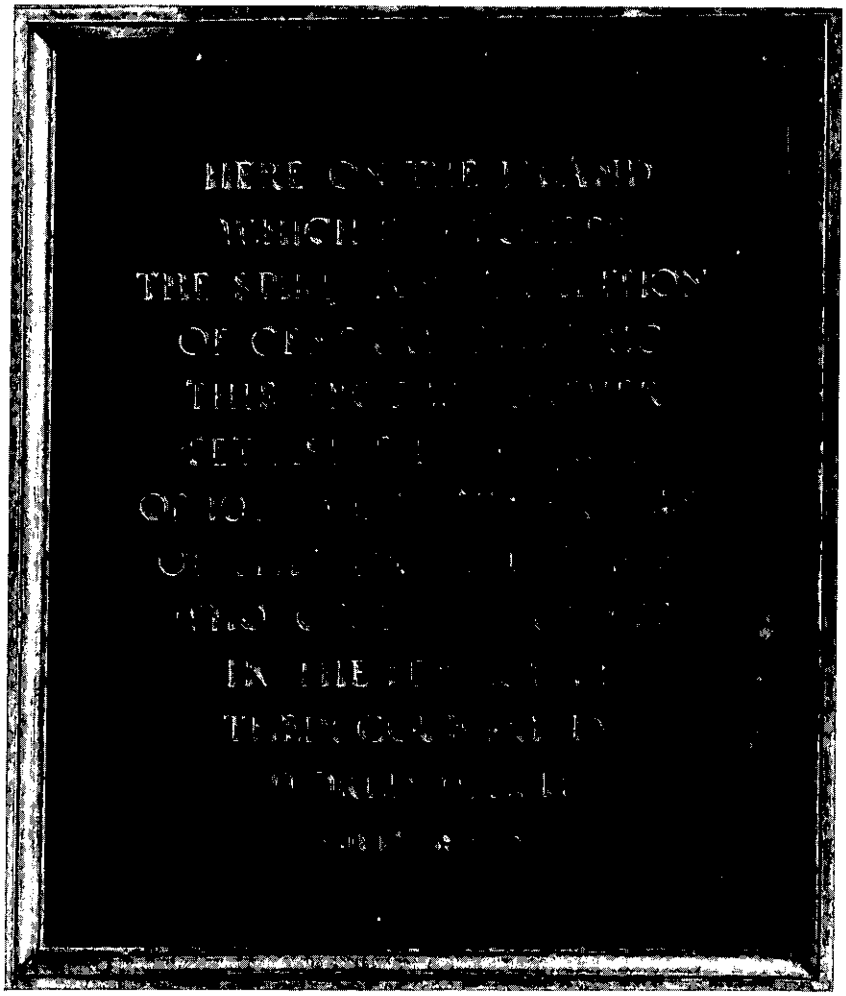
Production line at one of GE's turbosupercharger plants.

"The Battle of Kansas"

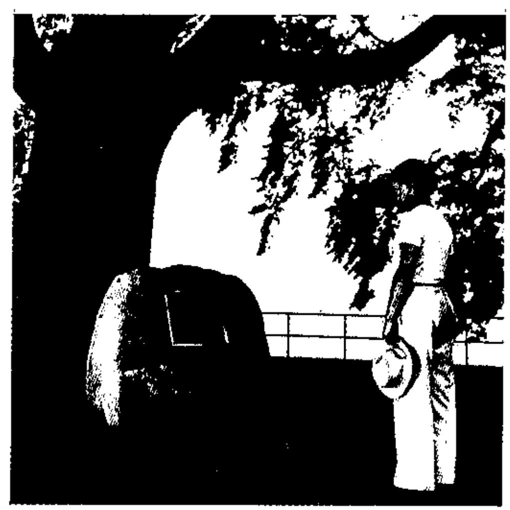
Early 1943, a call for help from the Air Force and Boeing. "Everybody needed in Kansas to help check out the B-29 fleet leaving for the Far East."

- **GE engineers and factory workers with tools and test equipment descended on Wichita, Kansas.**
- **Red tape is ignored, parts installed, systems checked out.**
- **As each B-29 soared away, a piece of GE went with it parts and efforts.**
- **It took months to straighten out the records and accounts, but the B-29s were in the air.**

The Supreme Sacrifice



50,000 General Electric men and women entered the armed forces during World War II. 1055 gave their lives in the service of their country. This bronze plaque was erected on Association Island in their memory.



1943-1944

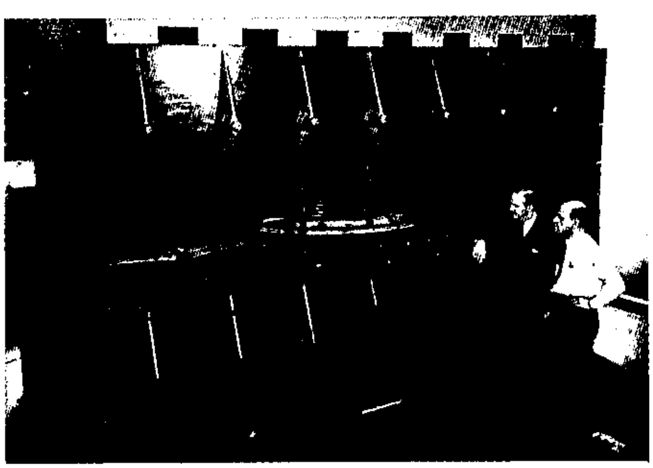
MATERIALS

A dense smoke generator for military applications is devised by Langmuir, Vincent Schaefer and Katharine Blodgett.

A new family of varnishes requiring no volatile solvents is developed in the Chemistry section, led by A.L. Marshall.

New high strength alloys for jet propulsion aircraft are developed in the continuing effort to produce faster-flying planes.

New silicone rubber gaskets that maintain their elasticity from -60° to 575° are developed for aircraft and other applications. Maynard Agens, James Marsden and others of the Research Laboratory collaborate with Edward Flynn and Thomas J. Rasmussen of the Schenectady Works Laboratory in the development of these and other silicone-based products, including specialized lubricating and insulating oils and greases, water repellents and resins for binding inorganic insulating materials.



100 million-volt electron accelerator, with E.E. Charlton (l.) and W.F. Westendorp (r.) in foreground.

C. James Marsden with silicone rubber gaskets for operation at extreme temperatures.

INDUSTRIAL EQUIPMENT

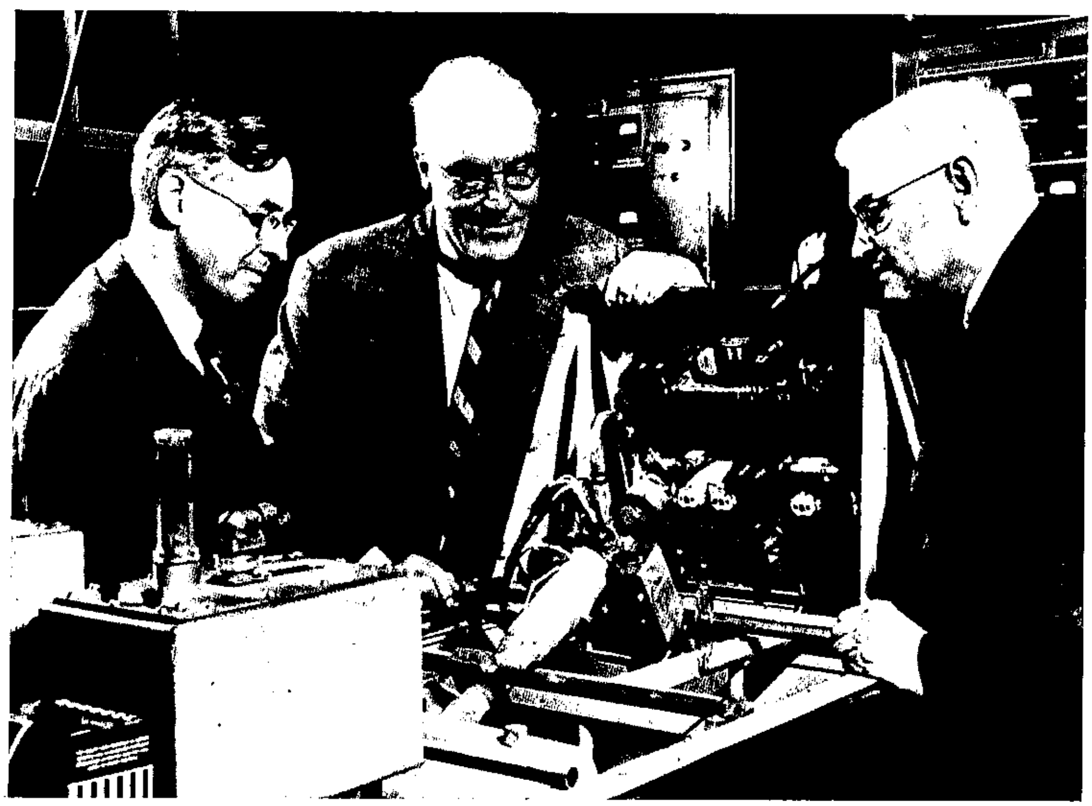
The world's most powerful electron accelerator, a 100-million volt unit, is completed as the result of work by E.E. Charlton and W.F. Westendorp. The "betatron" and its smaller predecessors are of great value in exploring the structure of the atom. A few years earlier, the first "betatron" had been devised by Donald W. Kerst while working at GE X-Ray. He went on to build a 2.5 Mev unit at the University of Illinois with the aid of GE scientists.

General Electric announces the first commercial mass spectrometer. The spectrometers are being manufactured by the General Engineering & Consulting Laboratory and marketed through the Special Product Section of the Apparatus Sales Department.

ORGANIZATION

Charles E. Wilson is again elected president of General Electric.

The new GE Credit Corporation is announced, with G.F. Mosher as president.



E.S. Lee (l.), D.C. Prince (c.) and C.M. Foust examine mass spectrometer.

1945

Circline fluorescent lamp.

LIGHTING

The circline fluorescent lamp is placed on the market. A 1-in. diameter tube, bent to the form of a circle 12-in. across, draws 32 watts and finds applications in portable lamps and ceiling fixtures.

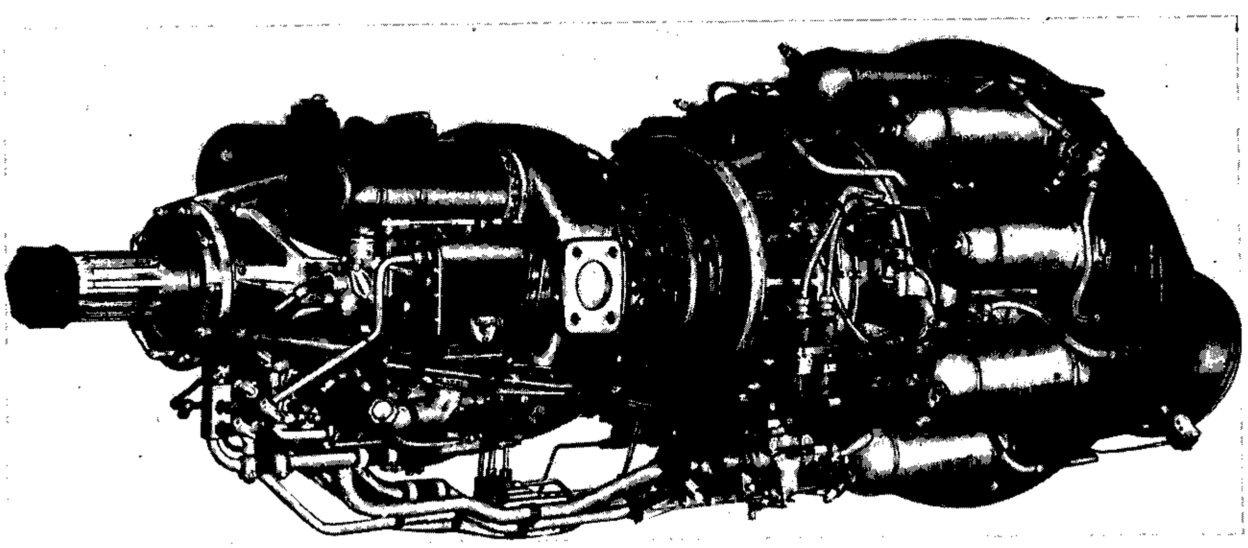
COMMUNICATIONS

General Electric demonstrates the first commercial use of radar, the electronic navigator with which vessels can detect, through darkness, unseen hazards as far as 20 miles away.

TRANSPORTATION

GE's second production turbojet, the 4200-lb-thrust I-40 (designated J33 by the Air Corps) is developed to power Lockheed's P-80 Shooting Star. The plane establishes a California-to-New York speed record of 4 hrs and 13 minutes. At 584 mph, it is faster than any plane ever flown by either side during World War II.

One of the world's first turboprop engines, the TG-100, is given its initial flight test in a Consolidated Vultee XP-81 plane. Developed at the Large Steam Turbine Department by a team headed by Alan Howard, the engine combines the thrust power obtained from the geared propeller with that of the axial flow gas turbine exhaust.

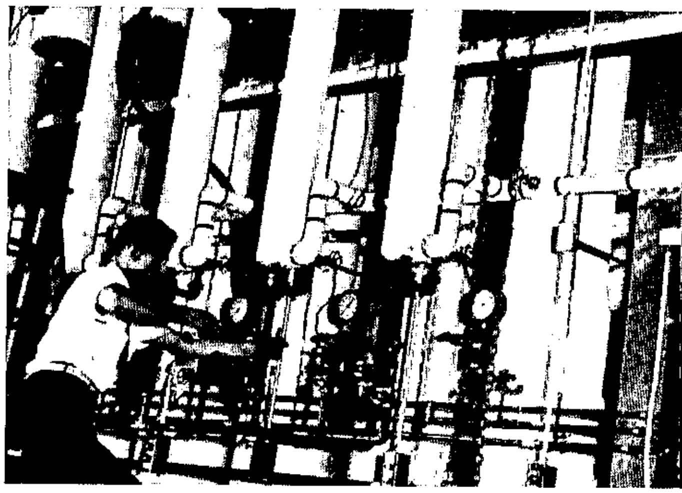


TG-100 turboprop engine.

MATERIALS

The new Chemical Department, headed by Zay Jeffries gets underway, with headquarters at Pittsfield, Mass.

Construction of a Silicone Products plant is started at Waterford, New York. Its operation is based on the use of the Rochow "direct synthesis" process (see 1940) developed to an engineering scale by Charles E. Reed.



Charles E. Reed (r.) directed the operation of the first GE pilot plant for the production of chlorosilanes — the precursors of silicones.

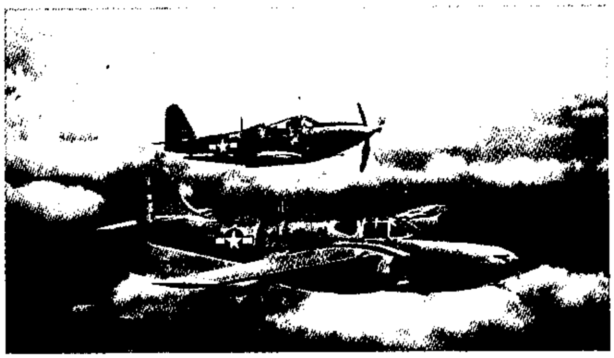
ORGANIZATION

Philip D. Reed is again selected Chairman of the Board after resigning his Government position.

C. Guy Suits succeeds W.D. Coolidge as Director of the General Electric Research Laboratory. Ground is broken for a new home for the Laboratory.

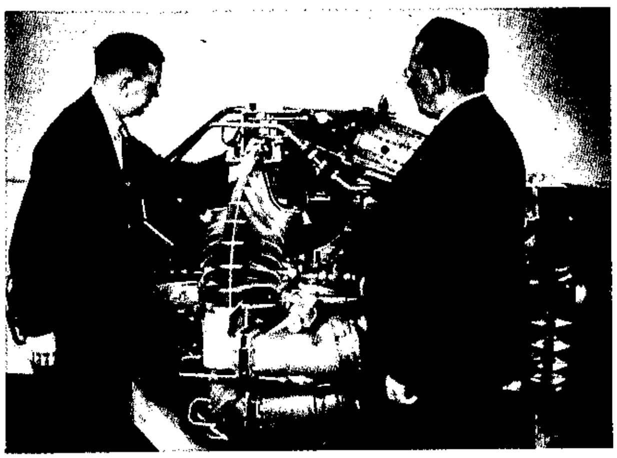
The Research Laboratory's first three directors: Willis R. Whitney (l.), W.D. Coolidge, and C. Guy Suits (r.).

THE BEGINNINGS OF THE JET AGE



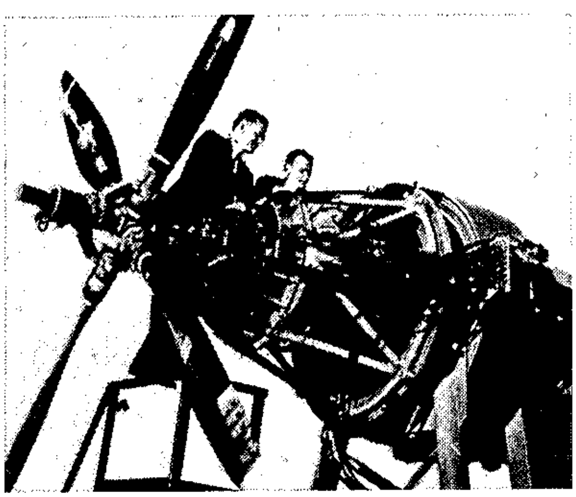
Bell XP-59, first American turbojet to fly, with two GE 1-A engines.

GE's flying laboratory, a U.S. Army Air Force B-29 Superfortress, with jet engine slung under fuselage for testing.

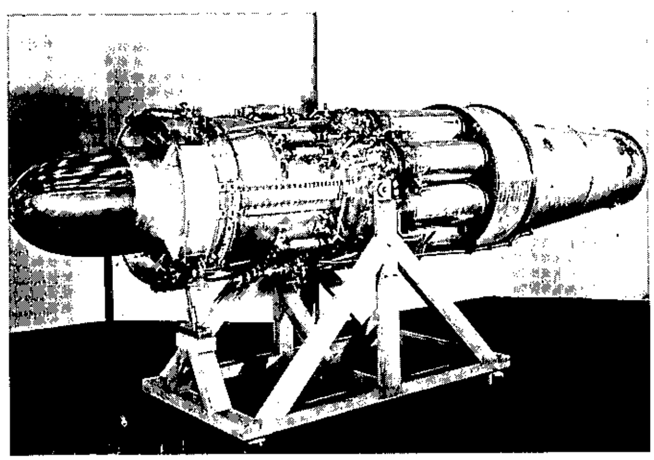


Dale D. Streid (l.) and G.R. Berg (r.) of Gas Turbine Division with a cutaway of I-40 (J-33) turbojet.

America's first operational jet fighter, the Lockheed P-80 Shooting Star, powered by I-40 (J-33) engine.



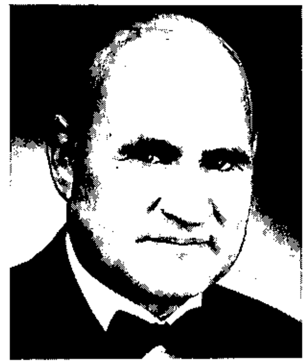
Alan Howard (l.) and Chap Walker (r.) inspecting axial flow TG-100 turboprop engine. A Consolidated Vultee XP-81 long range fighter, powered by the TG-100, was the first American plane ever flown with a turboprop engine.



The axial flow, TG-180 (J-35-GE). Its 4000-lb thrust powered a Republic F-84 Thunderjet to a record speed of 619 mph in 1946.

PIONEERING IN MAN-MADE MATERIALS

Zay Jeffries
1888-1965


Zay Jeffries

Highly honored worldwide for his early contributions to the science of metals, Zay Jeffries earned the equal respect of his business associates for his unusual ability to teach, promote and direct the application of scientific principle and advanced materials technology to beneficial use. He played a major role in the establishment of the chemical and metallurgical materials businesses of General Electric.

After graduating from high school in Pierre, South Dakota, Zay entered the South Dakota School of Mines, financing his education by working in the local mines. He was graduated in 1910 with the Degree of Bachelor of Science in Mining Engineering. He later received the Degree of Metallurgical Engineer from the same school (1914) and a Doctorate of Science from Harvard University (1918).

Following a year's employment in the gold mines, Jeffries accepted appointment as an instructor in metallurgy and ore-dressing at the Case School of Applied Science in Cleveland, Ohio. His early work there in the structure and properties of metals attracted the interest of Burnie L. Benbow, Manager of the Cleveland Wire Works who, in 1914, brought him into the General Electric Company as a consultant on problems associated with tungsten lamp filament production.

His important contributions to tungsten production and to the general research program at Nela Park led to his appointment as Chairman of the Technical Committee of the Incandescent Lamp Department in the early 1920s. His shift from active research to technical management was complete by 1928. By 1936, he had become a full-time General Electric employee with the title of Technical Director of the Lamp Department.

In 1926, he was introduced to cemented tungsten-carbide by Samuel L. Hoyt of the Research Laboratory and correctly evaluating its commercial potential, he used his by now considerable influence with Company management to promote the establishment of the Carboloy Company, a GE subsidiary, in 1928. He was a founding Director and successfully steered the fledgling company through the Great Depression, serving as President in the critical years 1932 to 1936 and as Chairman of the Board for several years thereafter.

Jeffries' wartime technical service to the nation began as Chairman of a National Research Council committee on the treatment of metals in World War I. In World War II, he was appointed Vice-Chairman of the Council's giant war metallurgy committee and served on the advisory board to the Manhattan Project. In a letter to Dr. Arthur Compton in 1944, he coined the term "nucleonics" and again demonstrated his great foresight in discussing atomic energy and its postwar applications.

In late 1944, at the request of Charles E. Wilson and Ralph J. Cordiner, Jeffries led a study of the chemical operations of the Company to determine the advisability of establishing a General Electric business based on their products. His positive recommendation was accepted, and he was appointed Vice President and General Manager of the new Chemical Department on January 1, 1945, with headquarters in Pittsfield, Massachusetts.

After electing early retirement in December 1949, he maintained his office at Chemical Department Headquarters in Pittsfield where he continued to be a source of advice and encouragement to his successors and particularly to his many young engineers and scientist friends concerned with materials and processes. Zay Jeffries died in May 1965 as he approached his 77th birthday.

During the latter half of his career, he received many medals and honors, and in his acceptances would always state his indebtedness to his teachers and mentors for their generosity, to his peers for their friendly cooperation and to his proteges for their dedicated labors. Even in his retirement years, he continued to repay this self-assumed debt in kind; and the numerous beneficiaries of this unofficial "Dean of American Metallurgists" testify to its more than full repayment.

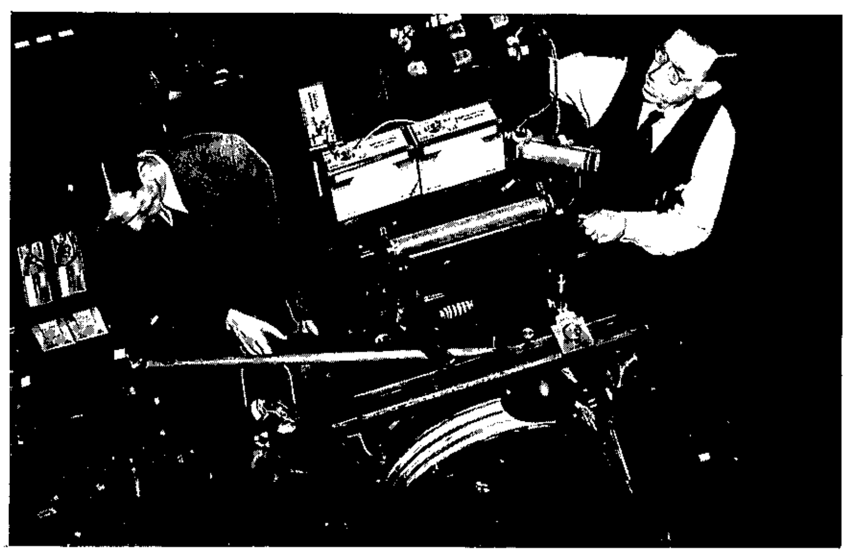
THE ADVENT OF NUCLEAR ENERGY

"It seems therefore possible that the uranium nucleus has only small stability of form and may, after neutron capture, divide itself nto two nuclei of roughly equal size. The two nuclei will repel each other and should gain a total kinetic energy of 200 Mev, as calculated from nuclear radius and charge." — L. Meitner and O.R. Frisch, Nature, February 11, 1939.

This was the exciting interpretation of a discovery in Europe by Hahn and Strassman that when uranium is bombarded with slow neutrons, isotopes of barium, lanthanum and cerium are formed. From theoretical considerations, it appeared probable that the uranium isotope of atomic weight 235 would fission more readily than the more abundant U-238 isotope. For this reason GE Nobel laureate Irving Langmuir recommended to William D. Coolidge, Director of the Research Laboratory, "It is very important (now for the first time) to work in nuclear physics and particularly to develop methods of separating isotopes on a large scale" — May 23, 1939. The following day a GE research team was at work on schemes to separate isotopes. To assess the success of any method required the construction of a mass spectrometer capable of resolving the isotopes. In those days, the construction of such a spectrometer was still a research task. The completed instrument was used early in 1940 by Kenneth H. Kingdon and Herbert C. Pollock to provide early samples of pure U-235 and U-238 to confirm experimentally at the Columbia University cyclotron that U-235 was indeed the isotope fissioned by slow neutrons.

While attempts to perfect new separation methods were in progress, the Research Laboratory became for a time a producer of pure uranium hexafluoride for other American laboratories that were also working on isotope separation. Cooperation with university scientists came easily, for under Whitney and Coolidge, scientists such as Arthur Compton, Ernest Lawrence, Jesse Beams and Frederick Seitz were at times consultants or employees of the Research Laboratory.

After the Manhattan Project was organized by the government to develop atomic weapons with speed and in secrecy, many engineering and manufacturing components of the Company became involved in supplying technology and equipment for new atomic development cities in Tennessee, New Mexico, and Washington. The work of the Research Laboratory began to focus more on critical problems relating to antisubmarine warfare radar, and countermeasures. But, in 1944, at the request of Ernest Lawrence and General Groves, Coolidge recalled Kenneth Kingdon from a torpedo project in Florida to take an eight-man GE scientific team to California to support research on isotope separation with the "calutron," a gigantic mass spectrometer developed by Lawrence at Berkeley. By this time, multiple beams with amperes of ions were being used to separate U-235 in the calutron factories at Oak Ridge, Tennessee.

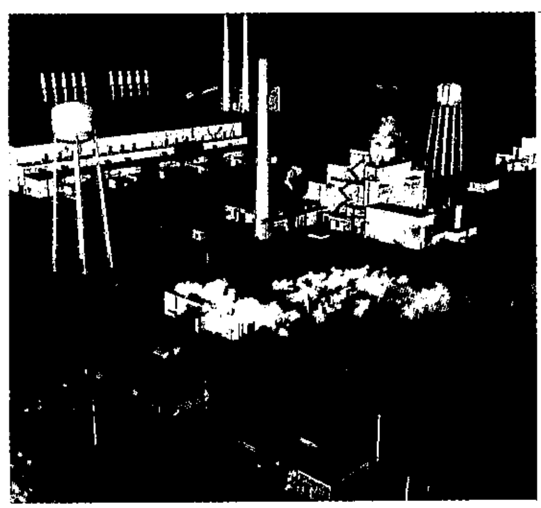


Herbert C. Pollock and Kenneth H. Kingdon with mass spectrometer used in isolating uranium (U-235) in GE Research Laboratory in 1940.

At the end of the War, when the DuPont Company withdrew from operating the plutonium producing reactors at Hanford, GE offered to take over the management of this facility and also to organize a new government-funded laboratory in Schenectady aimed at the development of nuclear power. Both plans were accepted by the United States Government and C. Guy Suits, who had succeeded Coolidge as Vice President of Research, expanded the staff of the Schenectady laboratories by hiring many able young scientists who had been active in nuclear research. Even before May 15, 1946, when the contract for the Knolls Atomic Power Laboratory was signed, scientists were beginning to arrive in Schenectady to work on new applications of nuclear energy, particularly the development of useful power. The Nucleonics Project, with Kingdon its Technical Manager, soon became the temporary Atomic Power Laboratory, on Peek Street in government-owned buildings previously used by the American Locomotive Company for army tank assembly. In the summer of 1947, ground-breaking ceremonies were held at the site of KAPL which was to become a key laboratory for the development of U.S. naval reactors. An initial KAPL project was aimed at demonstrating the engineering feasibility of a fast breeder reactor using an intermediate energy neutron spectrum. The successful operation of the "Submarine Intermediate Reactor" and the power plant of the submarine "Sea Wolf" validated the engineering concepts on which the modern liquid metal fast breeder reactor (LMFBR) is based. Henry Hurwitz, who led the theoretical section at KAPL, has written, "The successful operation of early naval reactors caused industry to give serious attention to the possibility of commercial light water reactors. The fact that the underlying technology of steam power plants was familiar and well developed gave industry the courage to aggressively undertake the commercialization of the LWR concept."

The time span assigned to this book does not include the history of General Electric's development of the commercial boiling water reactor (BWR), the feasibility of which was demonstrated in the early 1950s, and the subsequent growth of the Company's commercial nuclear power business. The efforts of many General Electric people, among them Harry A. Winne, Vice President-Engineering, who served on an important advisory committee for President Harry S. Truman, aided this country in the rapid development of the new nuclear technology.

Harry A. Winne



One of seven manufacturing plants of the Hanford Works, Richland, Washington.

1946

MATERIALS

"Snow-making" is announced by Vincent J. Schaefer of the Research Laboratory. He found that by dropping dry ice through a supercooled cloud, it was possible to nucleate snowflake formation.

Vincent J. Schaefer studying snow-making in laboratory.

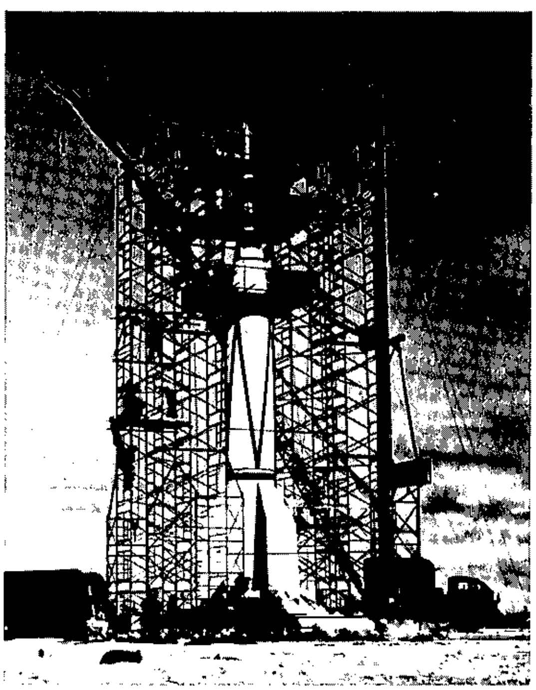
APPLIANCES

Within weeks after Japan's surrender, General Electric starts producing washing machines and other large appliances by "improved methods used in building bazookas."

TRANSPORTATION

The gas turbine project team at the Large Steam Turbine Department designs the axial flow TG-180 (designated J-35 by the Air Corps) turbojet engine for use in the Republic Aviation, Thunderjet F-84 fighter. The engine's 4000-lb thrust enables the plane to achieve a record 619 mph airspeed during its initial flight tests. Almost ten years earlier, Glenn Warren and Alan Howard had advocated the use of the axial flow compressor for high performance gas turbines.

A team of GE scientists led by Richard W. Porter works in support of the U.S. Government to help assemble and launch recovered German V-2 rockets at White Sands, New Mexico. The tests mark the beginning of the missile and space age in America.



Rocket test site at White Sands, New Mexico.

POWER GENERATION

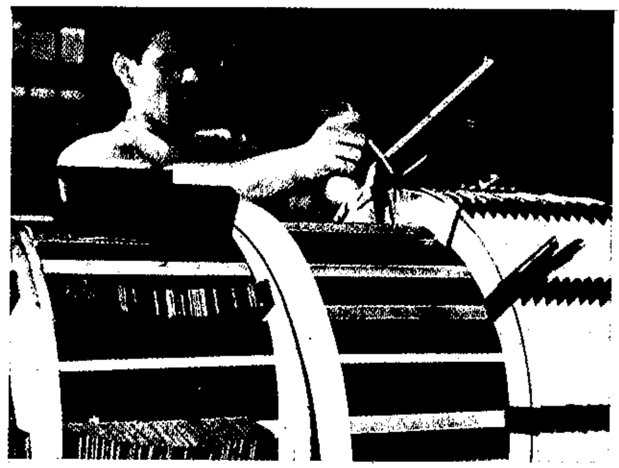
GE takes over operation of the U.S. Government's Hanford Works near Richland, Washington. In addition to the operation, development and enlargement of the Nuclear Works, GE's contract with the Atomic Energy Commission calls for research and development in the use of atomic energy as a source of power. Administrator of the facility is William H. Milton, Jr.

CONVERTING TO A PEACETIME ECONOMY

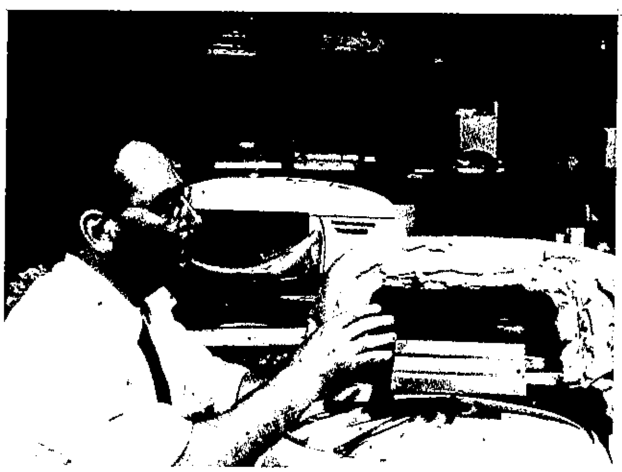
Preparing picture tubes for home television receivers at Electronics Department's Buffalo plant.

Checking radio sets to be used in private planes at Electronics Department's Syracuse plant.

The first post-war refrigerators on the assembly line at Erie.



Winding transformer coil at Pittsfield Works.



Designer creates a clay model for a washing machine at Bridgeport.

Designing locomotives to be built at Erie.

EPILOGUE

The battle for survival during World War II involved a commitment of material and human resources unmatched in the history of the United States. Philip D. Reed and Charles E. Wilson had been instrumental in mobilizing these resources in their temporary governmental positions and in their roles as Chairman of the Board and President of General Electric.

With the war over, they were faced with a new challenge: how to redirect the Company's production facilities, manpower, scientific and engineering talents to the needs of a peacetime economy. The nation needed the consumer goods, the industrial, transportation and utility equipment whose flow had been cut off by the war, and General Electric engaged in an enormous expansion program to supply these products.

Technologies in their infancy in the pre-war era or born during the war presented new opportunities for growth. Developments in electronics were to have effects in areas ranging from home entertainment to space communications. The advent of nuclear energy offered an opportunity to cope with a dwindling supply of natural resources. New man-made materials were to find their place in virtually every segment of life.

The jet engine was to revolutionize transportation and compress the size of the globe, not only for travel, but for world trade. Gas turbines, the youthful dream of Moss and Warren, were to come into their own in the fields of transportation and power generation. The rocket experiments in which GE engineers had participated in 1946 were preludes to the dawning of the Space Age and manned journeys into space. The possibilities were (and continue to be) unlimited — and it would take the imagination, daring and dedication of new generations of GE people to successfully lead the Company down these and other uncharted paths for progress.

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ACKNOWLEDGEMENTS

The names imprinted on the covers of this book are a mere sampling of the "Giants" to whom we referred in the Foreword. Limitations of space alone prevented us from including more individuals, or from describing in greater detail their roles in the record of accomplishment that is "The General Electric Story." We are beholden to many of our readers for their suggestions and for providing us with biographical and photographic material used in the preceding pages.

We would also like to thank a number of people who gave of their time and talents to make possible the production of this third volume in our Photo-History series:

Tim Sauter and other staff members of the Art and Photographic Units at GE's Research and Development Center were responsible for cover design and other phases supporting the production of the camera ready copy. • Peter Van Avery participated in the editing of the manuscript and provided valuable guidance with respect to style. • Catharine Welsh typed a major portion of the manuscript and offered many helpful suggestions regarding its format.

Finally, we wish to pay our respect to the numerous unidentified photographers who recorded for posterity the events of their time.

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THE GENERAL ELECTRIC STORY
1876—1923

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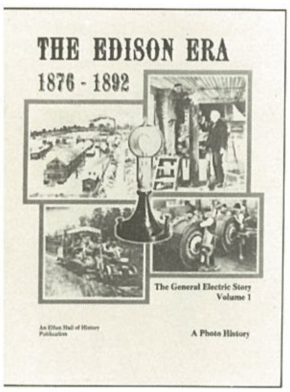
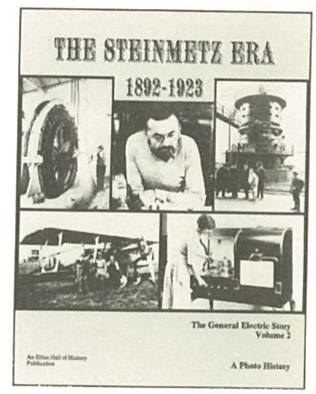


VOLUME I

Volume I, "The Edison Era," is replete with photos of Thomas A. Edison and his associates from the time he became well known with the invention of the incandescent lamp until the company he formed became the General Electric Company in 1892. Of this volume, GE Board Chairman R. H. Jones said: "A truly excellent job. Most impressive is the very strong emphasis on people. The story of General Electric is the story of people and you are helping all of us make certain that we never lose sight of this."

Volume II covers the era of Charles Proteus Steinmetz, the "Electrical Wizard." He came to GE late in 1892 and was instrumental in merging electrical technology and electrical science. This photo history contains many rare and previously unpublished photographs of Steinmetz, his contemporaries, and their achievements.



VOLUME II

These soft-covered photo histories are available at $2.95 per copy, tax included, postpaid, from The Hall of History, General Electric Research and Development Center, P. O. Box 8, Schenectady, N.Y. 12301. Please make your check payable to the Elfun Hall of History.

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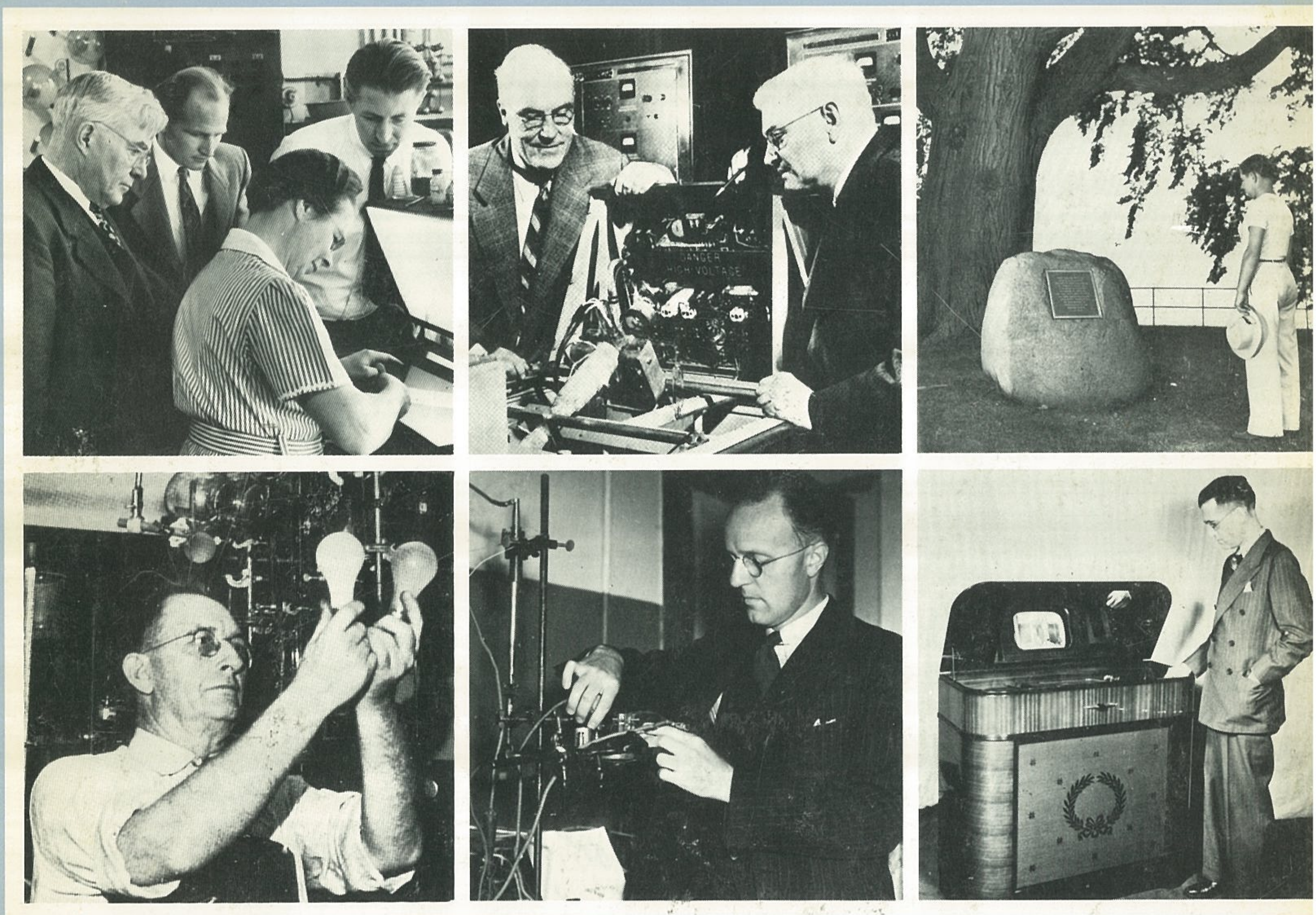

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