NATIONAL ACADEMY OF SCIENCES

# ELMER AMBROSE SPERRY

*1860—1930*

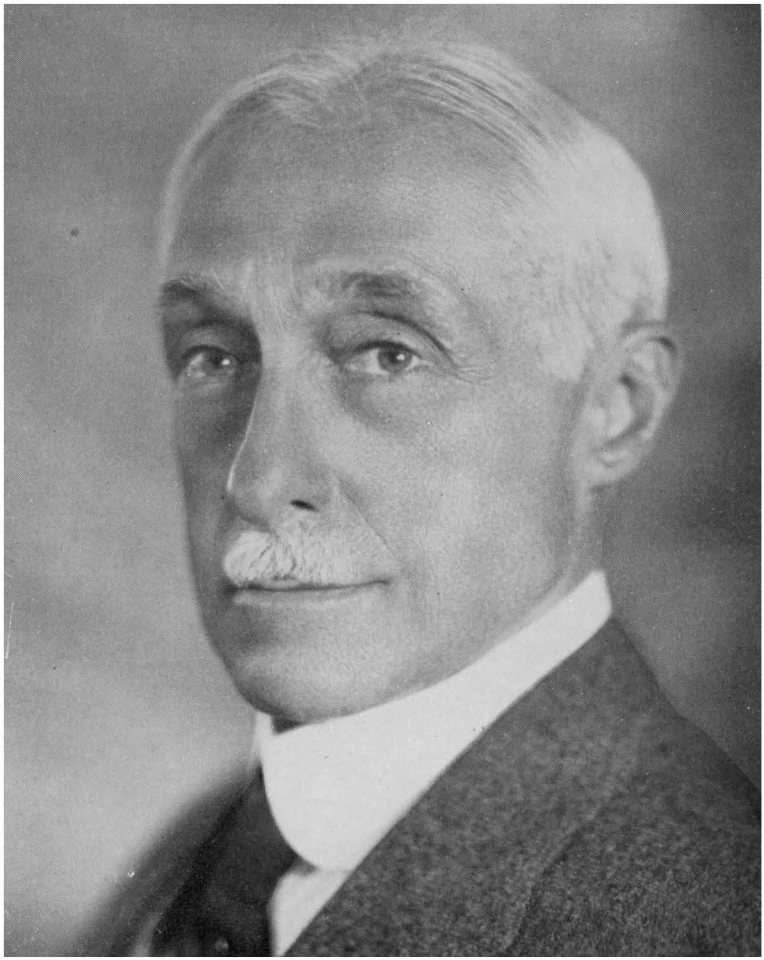
---

*A Biographical Memoir by*

J.C. HUNSAKER



*Biographical Memoir*



Elmer A. Sperry.

# ELMER AMBROSE SPERRY

## 1860–1930

BY J. C. HUNSAKER

Elmer Ambrose Sperry, inventor and pioneer in the field of applied electricity, was born to Stephen Decatur Sperry and his wife Mary Burst in Cortland, New York, October 12, 1860, and died in Brooklyn, June 16, 1930.[1] Richard Sperry, the first of the family to arrive in America, settled in 1634 just north of New Haven. In a cave on his farm he hid the Regicide Judges who condemned Charles I to death in the time of Cromwell. A ridge on the Sperry farm, recently tunneled for the Merritt Parkway, became the site of West Rock Park.

Elmer Sperry's mother died at the birth of her only child and he was reared by his widowed aunt, Helen Sperry Willett. His father worked for the Cortland Wagon Company, whose wagons were driven up and down the seven valleys radiating from Cortland and were occasionally taken by Stephen Sperry as far as New York or Chicago.

Young Sperry's inventive bent showed itself early. As a boy he built nutmeg graters, waterwheels, windmills and a tricycle that he could pedal on the railroad tracks, just ahead of the local freight, in exciting races to safety. He was fortunate to live in Cortland where he could attend classes at the State Normal School, one of the first schools in the United States to offer instruction in electricity. Sperry was a good student and electricity captured his interest. He began by constructing batteries in glass jars, insulating the wire as well as winding coils. He was allowed to install a system of electric bells in the school.

While still attending Normal School, Sperry visited Cornell University, a short buggy ride away. After graduation, he enrolled as a special day student at Cornell for the year 1879-80. The attraction was the laboratory in which Professors Anthony, Ryan and Sweet were building an electric dynamo. Sperry, a skilled mechanic from shop experience acquired during vacations

[1] Dictionary of American Biography, Scribners, New York.

at the Cortland Wagon Company, was allowed to help. When the dynamo was sent to the Philadelphia Centennial Exposition in 1875, he went along. Here he spent many fascinating hours in the Machinery Building where the complicated Jacquard loom, the Corliss engine with its great walking beam and flywheel, and another dynamo like the one from Cornell, but made by a Frenchman named Gramme, were all operating. Sperry remembered that trip for the rest of his life.

Copies of the *Patent Gazette* were available in the reading room of the Cortland Y.M.C.A., and it is reported that Sperry waited eagerly for each new issue to arrive. He believed implicitly in all mechanism illustrated in the Gazette, studying carefully each of the claims. Years later, some of our most able patent attorneys remarked that Sperry was the best claim writer of them all. Thus he acquired a soft spot in his heart for the Y.M.C.A. He contributed time and money toward its support during his lifetime and made it a generous gift in his will.

While Sperry was a student at Cornell, he began to work on ideas to improve generators and arc lights. This probably marked the beginning of his long inventive career. For nearly fifty years thereafter he was an unusually productive worker. He was granted more than four hundred patents, the most important dealing with dynamos, arc lights, electric locomotives, mining machines, trolley cars, storage batteries, electrochemistry, applications of the gyroscope, gun-fire control apparatus, and finally a method of detecting defective rails in track.

### *Dynamos, Arc Lights and Power Plants*

Sperry built a generator and arc light at the Cortland Wagon Company and illuminated the Christmas Festival at Cortland in 1879. On the advice of his father, who considered the city of Chicago the most progressive in the country, he took his arc light and generator there in 1880. He presented a letter of introduction to a deacon of the Baptist Church and rented factory space.

"On my twentieth birthday I opened my shop (The Sperry Electric Illuminating and Power Company) on West Quincy

Street," he wrote. "My first contact with electric lighting in Chicago came that winter in 1880-81 when I put in an installation of twenty lights on the Clark Street front of the County Building. The lights were stretched on long poles sticking out from the building all along the facade. The dynamo was running in the basement . . . .

"The next year I started one of the first central stations in Chicago, having my plant in the basement of the Commercial National Bank Building and extending my wires to the Chicago Tribune, the Inter-Ocean, Carson Pirie Scott, Kranze Candy Company, and a large number of small stores, restaurants, etc. in that vicinity. Later on I placed on the top of the Board of Trade Tower, 303 feet from the ground, a ring of lights aggregating 40,000 candle-power which were the highest and most powerful of the period. . . .

"Although most of the places lighted from this central station were lighted by arc lights, I remember we fitted up the composing room of the Chicago Tribune Building with a multiple series of incandescent lights from a large arc light generator."

Sperry's lighting business was very successful. He furnished light to Omaha and Council Bluffs. He had plants in Kansas City and St. Louis, and in several towns in Illinois, Indiana, and Ohio. He was awarded a contract for lighting the Interstate Exposition held in Chicago each year and won medals for excellence of apparatus. He also illuminated a large part of the World's Columbian Exposition of 1892-93. In Chicago B. E. Sunny bought out the Arc Light and Power Company which was using Sperry equipment and Sperry's downtown power station and, after acquiring other stations, put them together into an organization which later was expanded into the present Commonwealth Edison Company of Chicago. Sperry sold his arc light patents to General Edison Company of Schenectady, later combined with the Thompson-Houston Company as the General Electric Company.

### *High Intensity Arc Light*

Many years later, in 1914, the Navy needed a more powerful searchlight because of the increased range of naval turret guns.

Sperry joyfully tackled the job, which to him was like renewing acquaintance with an old friend. He sent a young research engineer, Preston Bassett, to the National Carbon Company where he was well received, for Sperry had been a big user of carbons. Many experimental carbons were made following Sperry's suggestions and tested under Bassett's supervision. A new type of arc was eventually produced which greatly increased the effectiveness of existing searchlights.

In the ordinary carbon arc, the light comes from the end of the positive carbon. The carbon surface, when heated to its volatilizing point, has a brightness of 160 candlepower per square millimeter, the maximum that can be obtained from the incandescence of solids. Gas, however, is capable of intrinsic brilliance in the neighborhood of 1400 candlepower per square millimeter. Sperry made his positive carbon with a core of cerium fluoride which consumed faster than the outside shell, forming a crater in which gas emanating from the core was heated to incandescence. This gave a brightness five times greater than the best previous continuous source of light, and made practicable a searchlight of a billion candlepower.

The new high intensity arc was soon recognized as an outstanding accomplishment. For years Sperry did all the military searchlight business, and his searchlight, when used with anti-aircraft guns, helped beat off night air raids over London and Paris during World War I. His military searchlight later found commercial application for airway beacons and airport floodlights.

As an unforeseen application, the Sperry arc light made a valuable contribution to the motion picture art. Its high actinic value permitted indoor photography of motion pictures without sunlight. It was generally adopted by the studios, especially after the "talkies" made outdoor work too difficult.

In 1920, S. L. Rothafel brought to Sperry the problem of proper vision for customers in the far-distant galleries of his projected Roxy Theatre. The old-style light would not give enough illumination to the screen for so vast a space. Sperry's light solved the Roxy problem and made possible picture pro-

jection before large audiences. It is still in general use in outdoor movies.

### *Electric Mining Machines and Locomotives*

After dynamos had become generally available for generating electricity, and transmission lines for conducting it, Sperry turned naturally to inventing and building machines to be operated by electric motors.

In the coal mines near Chicago cutting was done by pick-axe, and it took a strong mule to haul one small coal car out of the mine. While on his honeymoon in 1887, Sperry became acquainted with a mine operator and saw that electricity might revolutionize mining, but he was advised that copper wire would not hold up under corrosive mine water conditions.

Sperry found that a slight rise in the temperature of the copper wires would prevent condensation, and this he provided by maintaining a small current in the circuits. His first electric mining machine was designed to duplicate pick mining with the power of the stroke increased a hundredfold. A number of mines were equipped with these "punchers" with excellent results. Machines of this type were soon replaced by continuously operating chain cutters, designed by Sperry, which could cut much faster. Variations of this type of cutting machine are in general use today.

His machines increased coal production so much that Sperry rushed to completion an electric locomotive which could haul out 1,000 tons a day, replacing mine mules and their associated difficulties. To operate on the existing light tracks, the weight of the locomotive had to be distributed along the rails. Sperry conceived an eight-wheeled locomotive having two swiveling trucks flexibly mounted so that the wheels could follow irregularities in the track and at the same time maintain mechanical connection with a single electric motor.

Today in the mining display section of the Rosenwald Museum in Chicago is an exhibit: "Early Electric Locomotive from Northern Fuel Company's mine at Jacksonville, Ohio, where it was used continuously for eighteen years, designed by Elmer A. Sperry in 1887; weight, 8 tons; wheel diameter, 20″; motor, 60 horsepower."

The Sperry Electric Machinery Mining Company was incorporated in 1888 and in January 1890 received the first large order to be placed for electric mining machinery in the history of the industry. The order from Pickands-Mather and Company of Cleveland was for an entire plant with boilers, engines, three generators, switchboards, two locomotives, and sixteen chain-cutting machines. Then the "hard times" of the early 1890's brought the business to a standstill. Herbert E. Goodman, Sperry's brother-in-law who had been his general manager, raised new capital in Chicago and started the business again on Halstead Street under the name of the Goodman Manufacturing Company. Sperry put in more money too, with Frank S. Washburn who was made president. Sperry became vice-president and Goodman general manager. This company, now largely owned by the families of the three founders, is still doing business at the same address. Washburn later brought over an electrolytic process from Germany, and with Sperry advising as electrical engineer, set up a plant at Niagara Falls, making the beginning of the American Cyanamid Company.

Arthur D. Dana, who was Sperry's financial advisor and best man at his wedding, took a fuse wire producing machine Sperry had invented, and formed in 1889 the very successful Chicago Fuse Wire and Manufacturing Company. Dana also founded the Appleton Electric Company, with Sperry as president and A. I. Appleton, Sperry's former factory superintendent, as general manager, to make small motors and accessories. Sperry was an officer and a stockholder in these three Chicago companies. From Cleveland or from New York he assisted in the direction of their activities by correspondence. Later, needing money for his new inventions, he sold his Fuse Wire and Appleton stock to Dana and Appleton respectively.

### *Electric Trolley Cars*

Because Sperry had built electric mining locomotives, he was approached by a group of men faced with the problem of operating electric railways in hilly territory. In the group were Tom L. Johnson, later Mayor of Cleveland, and Myron T. Herrick, later Governor of Ohio and Ambassador to France. Sperry

built for them a hill-climbing trolley car using the principle of his mine locomotive, i.e., driving all the wheels mechanically from a single powerful motor through a coupling permitting relative motion between the motor, mounted on the spring-supported body of the car, and gears on the axles. Another innovation was an electrical braking system which has since been used extensively. His general mechanical scheme is used for the same purpose today on the single-motor Pennsylvania Railroad electric locomotives. Professor H. J. Ryan, Dr. Louis Duncan, and Dr. D. C. Jackson officiated at a competitive hill-climbing test at the Chicago World's Fair, which Sperry won.

The Sperry Electric Railway Company was organized in 1890 to manufacture cars in Cleveland, and Sperry moved his family there to a house at 855 Case Avenue. Soon cars were operating in Youngstown, Pittsburgh, Waterbury, and Philadelphia, and Sperry set up an office in New York at 29 Broadway. Several hundred cars had been made when the newly formed General Electric Company bought the business and Sperry's patents in 1894. Sperry became a consulting engineer to General Electric for a time.

### *Electric Automobile and Storage Battery*

Before disposing of the Sperry Electric Railway Company, Sperry designed an electric automobile[2] and had it built by the Cleveland Machine Screw Company. He took John D. Rockefeller, whom he met at the Baptist Church, for his first automobile ride. Two features of Sperry's electric automobile were far ahead of the time, four-wheel brakes and a non-reacting self-centering steering system.

The French owners of the Cleveland Machine Screw Company persuaded Sperry to take his automobile to Paris in 1896. There it proved so successful that manufacturing rights for France were purchased and the Cleveland Company received an order for 100 vehicles for shipment to France. American rights were taken over by the American Bicycle Company, and the car was marketed as the Waverly Electric.

---

[2] Electrical World and Engineer, July 22, 1899, p. 127.

The battery developed and patented for this car was the most important element because it became the forerunner of the portable lead storage batteries in use today. Sperry put his plates in a hard rubber container with an elastic plate support at the bottom. The plates had a porous pyroxylin envelope which held the active material in position regardless of rough usage. His automobile ran 100 miles on one charge of this battery at a time when 36 miles was considered good. The National Battery Company of Cleveland was formed about 1900 by R. L. Coleman, president of the American Bicycle Company, to manufacture the battery with Sperry as chief electrical engineer. The company was moved to Buffalo in 1901 and taken over by a railway car lighting company in which Walter Chrysler and John N. Willys were active. When these men switched from railroad equipment to automobile manufacture, the company was merged into Electric Auto-Lite.

### *Electrochemistry*

Sperry's work on the automobile battery led him into electrochemistry, and in 1900 he equipped a research laboratory in Washington with Clinton P. Townsend as electrochemist in charge. Sperry supplied the cash and his knowledge of electrical engineering. During the laboratory's ten years of existence a number of useful processes were evolved, the most notable of which was the Townsend process for the manufacture of caustic soda from salt, accompanied by the production of hydrogen and chlorine. This process became the basis of the business of one of the largest American manufacturers of caustic soda and chlorine products, the Hooker Electrochemical Company of Niagara Falls.

In 1904 Sperry contracted with the American Can Company to develop a chlorine detinning process, and the following year moved his family to Brooklyn, where he lived for the rest of his life. A new detinning process was developed which also produced a product more valuable than tin. This product, anhydrous tetrachloride of tin, was sold to the silk industry to replace the bichloride of tin then used in processing silk. Sperry made arrangements for the American Can Company to operate

the detinning process at Carteret, New Jersey, on the basis of some thirty Sperry patents. Several plants were erected across the country under the name of Goldschmidt Detinning Company, now the Metals and Thermit Corporation, controlled by the American Can Company.

When the business tide was low after World War I, Sperry attempted another electrochemical process, this time in his Brooklyn laboratory. The problem was to make white lead electrolytically from impure pig lead or from waste products of copper refining. Many diaphragm materials were tried in the electrolytic cell.

Colburn Pinkham, the controller of the company, showed Sperry a new shirt he was wearing which was made from a material that his brother in the textile business was marketing for the first time. It was called mercerized cotton. Sperry cut a piece from Colburn's shirt tail and put it under the microscope; it was just what he was looking for. A successful process was developed to make from impure lead a chemically pure product of intense whiteness superior to that yielded by the old Dutch method then in use. The process was sold to the Anaconda Copper Company and a large plant was set up at South Chicago.

### *Gyro Stabilizer*

While Sperry worked on his electric carriage in Cleveland in the 1890's, he became interested in popular science articles on the gyroscope and discussed with Professor Dayton C. Miller of the Case School of Applied Science the possibility of using a gyroscope to keep his vehicles from tipping over. The electric carriages in those days had large-diameter, solid-tire wheels and full elliptical springs. The center of gravity was high off the ground and care had to be taken not to upset. Sperry had many an embarrassing spill, but he never put a gyro in his automobile. Instead, after a rough trip across the Atlantic he started thinking about a gyro stabilizer for ships at sea. He read everything Dr. Miller had on the gyroscope and sought further information abroad. Later he traced Leon Foucault's original gyroscope of 1850 to the Kensington Museum in London where it had been sent for safekeeping during the

Franco-Prussian War. There he got the curator interested in moving it from its obscure location to a prominent glass case on the main floor near the spot where Foucault's pendulum was swinging out its famous demonstration of the earth's rotation. Sperry wrote the placard for it.

Sperry began by using toy gyroscopes on a homemade model of a ship stabilizer. This he soon replaced by a larger model mounted on a pendulum. He then designed a ship stabilizer, employing an electric motor to control the precession of the gyro so as to keep the stabilizing force in phase with the rolling of the ship. He interested Naval Constructor David W. Taylor, later Chief Constructor of the U. S. Navy. Together they developed experimental apparatus that seemed successful in tests at the Ship Model Basin in Washington. Sperry then received an order from the Navy to stabilize the destroyer *Worden.*

Sperry undertook two other installations—one for the naval transport *Henderson,* the other for the *Osborne.* A larger stabilizer was constructed for the Japanese airplane carrier *Hosho,* and a still larger installation, comprising three gyros, for the 35,000-ton *Conte di Savoia* of the Italian Line. Several large yachts also were fitted with gyro stabilizers, but the equipment proved to be too expensive. The extra weight, expense and maintenance difficulties of gyro stabilizers were never fully acceptable to ship operators and Sperry's installations, though quite effective, were not continued.

### *Gyro Compass*

Another possible use of the gyro which began to attract Sperry's interest about 1908 was for a ship's compass. There was urgent need for a compass which would not be subject to the vagaries of the magnetic field on steel battleships. Turning gun turrets shifted the magnetic compass indication sometimes as much as twenty-five degrees. Foucault had predicted in 1850 that it should be possible to make a gyroscope sense the earth's rotation and point true north. However, he suggested no practical way to accomplish this. In Foucault's time there was no electric motor available to keep the gyro spinning. Sperry saw another opportunity for an electric motor, first, to

spin the gyroscope and, secondly, as a chaser to turn the top end of Foucault's suspension wire to keep it in alignment with the gyro element as the ship turned in its course.

As Sperry was tied up with the detinning process for the American Can Company, his ship stabilizer, and other activities, he called in his friend Hannibal C. Ford, an extremely clever designer of intricate apparatus. Ford and Sperry together started on the design of a gyro compass in a rented work room at 18-20 Rose Street, New York. As a sideline they designed a small gyro stabilizer for an airplane then being built by Stanley Y. Beach of the *Scientific American.*

By the spring of 1910, there was so much going on with gyros for compasses and for ship stabilizers that Sperry decided to form another company to take over gyro work. On April 19, he rented larger quarters at 40 Wall Street and formed the Sperry Gyroscope Company. The detinning process was now in full operation at Carteret, New Jersey, and Sperry was able to devote full time to the new company. There was no outside financing; Sperry put in the cash he had received from the American Can Company and sold all of his securities except the Goodman stock, whose dividends supported his family.

By 1911, his first gyro compass was ready for sea trials. After a preliminary run from New York to Norfolk on the *Princess Anne* of the Old Dominion Line, the compass was delivered to the U.S.S. *Delaware.* Hannibal Ford went aboard to superintend the installation, and Sperry joined him later to witness the tests. By the time the tests were completed, the Navy had two gyro experts, Lieutenant R. E. Gillmor, who mastered the theory, and Chief Electrician Thomas A. Morgan, who made the compass operate. The tests were successful and soon Sperry had a trial order for four gyro compasses. Business prospects for this new scientific gadget looked good and more help was needed. Gillmor and Morgan resigned from the Navy to join Sperry. Within a year Gillmor had a London office and was demonstrating the gyro compass before the Admiralty and the Royal Society. Sperry rented space near the Navy Yard in Brooklyn to produce compasses. Soon Morgan was installing the new compasses on battleships, cruisers,

and submarines of the British, French, Italian and Russian navies. Trials were in progress on a German naval vessel at the outbreak of World War I. The engineer in charge had to get off in a hurry and leave the instrument on board.

The effect of World War I on the demand for Sperry's gyro compass was enormous. The instrument grew in importance with every sea engagement. The Sperry Gyroscope Company was overwhelmed with the task of equipping simultaneously the United States Navy and the allied fleets. Sperry borrowed money from the Bank of America and built a large factory at Manhattan Bridge Plaza, Brooklyn, in 1915-16, and the Sperry Gyroscope Company, Limited, was formed in London with Gillmor as managing director to build gyro compasses for the British and other allies.

Later the gyro compass was arranged to control the steering engine so as automatically to hold a ship on any predetermined course. This "Metal Mike" was in fact a robot helmsman more capable of sensing and correcting small deviations from course than any sailor and, furthermore, without the usual human limitations due to fatigue and exposure.

### *Gun Fire Control*

While waiting for the *Delaware* to return from the coronation of King George V, Sperry arranged with the Bureau of Ordnance of the Navy to have his gyro compass installed on the U.S.S. *Drayton* in order to demonstrate the possibility of using a repeater compass in the plotting room to indicate there the true heading of the ship. The ordnance experts liked the electrically connected repeater compass, and asked Sperry to make a further connection with a telescope above decks to indicate the angle that the target bore from the bow of the ship. Sperry put a target-bearing pointer on top of the repeater compass dial, so that target bearings, as well as the true heading of the ship, could be read off.

Admiral Joseph Straus, Chief of Naval Ordnance, urged Sperry to observe target practice and to examine the basic fire control problem of long-range guns. He found in Sperry a man who not only grasped the problem instantly, but who could

propose a solution. This was the start of another fruitful field of invention and design for Sperry which he carried out over the years with successive Chiefs of Naval Ordnance; Earle, Fiske, Sypher, Overstreet, etc.

A new concept of gunfire control was evolved by Sperry and the U. S. Navy ordnance experts. The entire battery should be operated as a single unit and directed in both elevation and train from one sighting point. To this end Sperry devised an accurate electrical system for transmitting to all guns the proper angles of elevation and train, introducing the necessary corrections automatically from instruments located in the plotting room below decks. Finally, the whole battery must be fired in salvo by one officer in the top controlling the firing. The gyro compass came into the system to keep the guns trained on the target at all times, irrespective of course changes. The various electrical and mechanical elements working in combination as a system required an over-all precision of operation never before thought possible. Sperry's fire control system was installed during World War I on all of the battleships of the United States Navy—some thirty in number.

After World War I Sperry in collaboration with the Army Ordnance Department developed a mobile anti-aircraft fire control system. Searchlights and sound locators (now replaced by radar) were added to take care of the difficult night phase of the problem.

### *Airplane Automatic Pilot*

In 1913 conditions seemed ripe for resuming the airplane stabilizer work started but discontinued in 1910. Sperry knew Glenn Curtiss at the Aero Club in New York, got in touch with him, and arranged to send his son Lawrence to Curtiss's shop at Hammondsport. Lawrence Sperry had already built and flown his own airplane and later was awarded F.A.I. Pilot's License No. 11.

This time Sperry's approach to the airplane stability problem was different. Instead of counting on direct gyro-stabilization of the airplane, he devised a gyro unit which held only itself stabilized in the horizontal plane. From this unit, electrical contacts actuated the clutches of servo-motors which in turn

operated the ailerons and elevators of the airplane as a human pilot would.

The Aero Club of France announced an international competition for a safe airplane with a prize of 50,000 francs to be awarded to the winner. Curtiss, in whose flying boat the gyro stabilizer had been tested, persuaded Sperry to send Lawrence to Paris to compete for the prize. The demonstration flight was made in June 1914.

As the plane flew low past the judges' stand the mechanic climbed out on the wing and Lawrence stood up in the open cockpit raising both hands above his head. This was indeed convincing; nothing like it had ever been seen before. He won the prize.

Unfortunately for Sperry, during World War I an airplane stabilizer was not wanted. Aerial combat was a "dog fight," each pilot trying to out-maneuver his adversary. Stabilization was the last thing he needed. While the airplane gyro-stabilizer had no active part in the war, under the cloak of military secrecy it was applied to an experimental "aerial torpedo," fundamentally similar to the German V-1 of 1943—twenty-five years, or one World War, ahead of its time.

### *Aircraft Instruments*

The ship's gyro-compass was too big and heavy for an airplane, and moreover a fast airplane flying west at our high northerly latitudes can interfere with the effect of the rotation of the earth in making the gyro point north. Sperry took a license to build a British magnetic compass but encountered difficulty with the so-called Northerly Turning Error. When a pendulous compass card is tilted by centrifugal force in a turn, the dip of the earth's magnetic field causes the compass magnets to turn the card so as to indicate to the pilot a turn in the direction *opposite* to that in which he is actually turning. Pilots caught in a fog were being killed from a spiral dive into the ground.

Sperry solved the problem in 1917 by the invention of perhaps the greatest flight safety instrument in the history of

aviation—his Gyro Turn Indicator. Flying straight courses by means of the turn indicator kept the pendulous compass card level and reliable. A little practice even enabled a pilot to turn to and hold any desired course. To this instrument was later added a ball in a curved tube as a bank indicator to become the Turn and Bank Indicator. Later the Directional Gyro and the Gyro Horizon were added to form the nucleus of a group of flight instruments in use on every airplane flying today. James H. Doolittle was the first to put this combination together, and by using it in addition to local radio beams, made history in September 1929 by making the first "blind" take-off, flight and landing of an airplane.

While the gyro-stabilizer as such did not find application directly to the airplane, it soon re-entered the picture in the form of the Sperry auto-pilot. This instrument used a combination of gyroscopes to control servo-motors to operate the three controls of the airplane to hold it on a desired flight path. It was the forerunner of all automatic pilots to follow, and has become standard equipment on all large airplanes, both civil and military.

### *New Corporations*

Sperry the inventor was frequently forced by his success to become Sperry the promoter. Engineering and manufacturing help, and always money, had to be found. In a few instances he could sell his patent rights to established concerns, as in the cases of his storage battery and his electro-chemical processes. But his major inventions required the development and marketing of an entirely new product. For this a new company had to be financed and staffed. A dozen or more Sperry concerns were set up, of varying degrees of vitality, the principal one being, of course, the Sperry Gyroscope Company.

The success that Sperry was having as an inventor prompted some of his young assistants to go into business for themselves after World War I. Hannibal Ford left to form the Ford Instrument Company, and Mahood and Davis founded the Arma Corporation. Colvin, Titterington, and Goldsboro left to form the Pioneer Instrument Company, and Carl Norden

established Carl L. Norden, Inc. to make a bomb sight and to undertake other ordnance developments.

In 1925, Sperry, not wishing to load the Sperry Gyroscope Company with his inventions that were unrelated to products of that company, started the Sperry Development Company, changed in 1930 to Sperry Products, Inc.

In 1928 when Sperry was sixty-eight years old his health began to fail. In that year the Sperry Gyroscope Company was sold to his good friend C. M. Keys, who put it into the North American Aviation Company, together with Curtiss-Wright and several other airplane concerns. After the financial crash of 1929, T. A. Morgan, then president of Sperry Gyroscope Company, became president of North American Aviation, and reorganized it by separation into three independent corporations; Curtiss-Wright, North American Aviation including Eastern Airlines, and the Sperry Corporation. Into the last he put the Sperry Gyroscope Company, later adding Ford Instrument Company, Waterbury Tool Company, and Vickers Hydraulics, Inc. Sperry Corporation is now a large publicly owned enterprise, listed on the New York Stock Exchange and employing thousands of people.

It is of interest to note that T. A. Morgan, R. E. Gillmor, and Preston Bassett, who had joined Sperry in his pioneering days, continued in active leadership of the Sperry enterprises.

Morgan retired in 1952, as Chairman and President of the Sperry Corporation, after forty years of service. Gillmor, now Vice-President of the Sperry Corporation, was succeeded as President of the Sperry Gyroscope Company by Bassett.

Sperry, though relieved of major business responsibilities, could not slow down. His inventive mind was too active. He resumed previous work on a compound supercharged Diesel engine, an automatic transmission for automobiles, a variable-pitch propeller for airplanes, an automatic railroad track inspection apparatus and a rail flaw detector. The last two constituted his major interest in the last two years of his life.

### *Track Recorder Gyro*

In 1929, President Hoover, after a reception at the White House, sent off the U. S. delegates to the World Engineering Congress in Japan. At Chicago their special train was transferred to the Santa Fe where they were handed a mimeographed announcement:

"It is assumed that we are all familiar with the intimate connection that our Chairman, Mr. Sperry, has for many years had with the gyroscope. It is, however, probably not known generally that one of the uses that he had worked out is the application of the gyroscope to railroading.

"This application relates to placing inspection of road bed and track on a strictly scientific basis. . . . The gyroscope gives an accurate and dependable base line against all movements of the car body. . . . The outstanding feature of this method of track inspection is that the service is performed under full-load conditions, . . . instead of relying on the inspector's judgment of the condition of the road bed after the loads have passed and the tracks have sprung back. . . .

"The excellent condition of the road bed on the Santa Fe lines . . . is measurably due to this novel scientific aid. . . .

"As a special courtesy to the engineers en route to the Tokyo Congress, this car has been taken out of service and will be attached behind the train for two hours out of Kansas City. . . .

W. B. Story
President"

### *Rail Flaw Detector*

As a result of increasing axle loads, small internal cracks, not visible to inspection from outside, were growing in proportion to the tonnage of trains passing over the tracks, frequently causing a break and derailment. Many schemes for detecting fissures in track were being tried. Sperry reviewed everything that was being developed, especially a magnetic method. He correctly guessed or intuitively knew that a small fissure, because the opposing faces were so close together, would not hinder the flow of magnetism nearly as much as it would the flow of a low-voltage current. Sperry told his railroad friends he thought an electric current method offered promise.

Sperry appeared before the Rail Committee of the American Railroads Association in 1926 and offered to set up laboratory

equipment and to make tests. The A.R.A. supplied rails from all parts of the country for test. Sperry bought a 2,000-ampere, 6-volt generator and tested the rails, marking the locations of fissures. The rails were then broken in the presence of a committee which reported a perfect score for Sperry. In October 1927, the A.R.A. commissioned Sperry to put his laboratory equipment on a car, and to test rails in track. The car was run over a test track made up of fissured rails at Beacon, New York, but the car did not notice any fissures. The method that had worked so well in the laboratory would not work under normal track conditions. A film of oxide and dirt rolled into the surface of the rail made it impossible for the low-voltage contacts to work reliably. But failure had come to Sperry before and he quickly devised a new scheme for detecting the fissures. The principle of passing a direct current through the rail was retained, but contact brushes for the indicator were replaced by small search coils riding above the rail in the magnetic field surrounding the rail. A fissure in the path of the heavy current would distort the magnetic field around the rail, thus inducing an electric potential in the moving search coils. This potential was amplified and recorded on a tape synchronized with the rail while a spot of paint was sprayed on the rail to show the location of the defect.

This detector car was hailed by the Bureau of Safety of the Interstate Commerce Commission as the greatest advance in the safety of railroading in sixteen years.[3] Sperry was "in the hole" financially about one hundred thousand dollars.

At the time of Sperry's death in 1930 Sperry Rail Service was operating ten cars. Now twenty cars are in operation, testing annually 160,000 main line miles in the United States and Canada. Altogether over one-million defective rails have been located in two million miles of track as a result of Sperry's invention and its reduction to practice through business enterprise. It is noteworthy that still another going business was created by Sperry after his apparent retirement at the age of 68.

[3] I.C.C. Report, 1927, pp. 90-91.

### *Naval Consulting Board*

During World War I Sperry was an active and enthusiastic member of Thomas A. Edison's Naval Consulting Board and served as chairman of three of its committees: Aeronautical, Mines and Torpedoes, Aids to Navigation.

Sperry may not have been a very good committee chairman and it is likely that he supplied more ideas than could ever be developed by his committees. It is recorded that Sperry proposed schemes for an optical range indicator, an electrically driven torpedo gryo, a buoy to announce by radio the near presence of a submarine, an airplane gun sight, a device for determining the range for fuse setting and for target altitude and azimuth, and a bomb sight and automatic bomb dropper with gyro-stabilized equipment.

He assisted in the development of improved depth bombs for use against enemy submarines and his company manufactured 10,000 of them. He also raised the power of his own anti-aircraft searchlight to some two-billion candle power. It was visible as a beacon light for 100 miles.

His service to the Navy was summarized by Secretary Charles Francis Adams in these words:

"His numerous inventions, including his gyro compass, airplane stabilizer, high intensity searchlight, and his apparatus for accurately controlling the fire of our guns, have assisted materially in placing the Navy in first class fighting trim. It is safe to say that no one American has contributed so much to our naval technical progress."

### *Honors and Awards*

Sperry was a frequent contributor to the proceedings of engineering and scientific societies both here and abroad. He was a founder member of the American Institute of Electrical Engineers, the National Electric Light Association, and the American Electrochemical Society. He was a member of the Society of Automotive Engineers, Society of Naval Architects and Marine Engineers, American Chemical Society, American Petroleum Institute, and the American Physical Society. He

served as chairman of the Division of Engineering and Industrial Research of the National Research Council, president of the New York Electrical Society and of the American Society of Mechanical Engineers. He became a member of the National Academy of Sciences in 1925.

Sperry was an enthusiastic joiner. He was an active member of the Aero Club of America, the National Aeronautic Association, the Japan Society, the Edison Pioneers, the Engineers Club, the American Association for the Advancement of Science, Sigma Xi, and Tau Beta Pi. He was an honorary member of several foreign professional societies and was always interested in the Baptist Church, Y.M.C.A. and other social groups.

Medals and awards were received at expositions for arc light systems, mining machines, and trolley cars. He received two medals from the Franklin Institute—the Franklin Medal in 1914 and the Elliott Cresson in 1929. He received the Grand Prize of the Panama-Pacific Exposition for his gyro compass in 1915; the Collier Trophy in 1915 for his drift indicator and in 1916 for his turn indicator; the Scientific American Medal in 1915; the Czar of Russia's Decoration for Navigating Instruments; the Order of the Rising Sun in 1922 and the Order of the Sacred Treasure in 1929 from the Emperor of Japan. He received the John Fritz Medal of the United Engineering Societies in 1926; the Holley Medal of the American Society of Mechanical Engineers in 1927; and the first Gary Medal of the American Iron and Steel Institute in 1929 for his fissure detector. He was honored by Stevens Institute, which conferred on him the degree of Doctor of Engineering, honoris causa, and by Lehigh University and Northwestern University, each of which awarded an honorary degree of Doctor of Science.

## *Personal Notes*

Sperry's lifelong abstemiousness stemmed from his strict Baptist upbringing. He maintained that the church and the people one met there gave a boy a good start in life, mentioning with pride members of his own Sunday School class, among whom were Chester and Theodore H. Wickwire of the famous wire works; Judge Alton B. Parker, Democratic candidate for

the presidency of the United States; Judge Edward B. Thomas of the Supreme Court, New York State; and Charles H. Duell, Commissioner of Patents.

When Sperry presented a letter from his pastor in Cortland to the Deacon of the Baptist Church in Chicago, he was asked to come back next Sunday after the service and meet some of the people. This he did, and among them was the Deacon's daughter. Before long Sperry was teaching a Sunday School class in a most original fashion, giving talks on all sorts of subjects including lighting and electricity. In addition to his regular classes, he held special meetings to which he invited boys from outside the church. Many of these boys joined the Sunday School. One of the most faithful members was a boy named Eddy Foy, who had become acquainted with the class through a group of newsboys. Years later, whenever Sperry saw Foy's name on a theater marquee, he would duck in at the stage door to be noisily welcomed by the actor in his dressing room.

Mention has been made of Sperry's meeting the Deacon's daughter in Chicago, Zula Augusta Goodman. They were married in 1887 and had four children, Helen (Mrs. Robert B. Lea), Edward (deceased), Lawrence (deceased) and Elmer. Sperry was fortunate in his marriage to a woman gifted with the imaginative capacity to go beyond her own life and experience, together with a wise tolerance for the intensive drive of her partner. To him she often read aloud many hours a day especially during their summers at Bellport, Long Island. This was Sperry's greatest relaxation. He liked biographies, novels and detective stories. There is a painful family recollection of other readings on electrochemistry and detailed patent specifications, followed from a, b, c, etc., down to the triple z on the drawing.

Mrs. Sperry's quiet sympathy and encouragement were important when frustration and doubt plagued the inventor and when business reverses plagued the promoter. Her joy when a brain child really flourished must have been rewarding. Sperry's greatest reverse, to which he never became reconciled, came

from the loss in 1923 of his son Lawrence, flying alone over the North Sea in an airplane of his own design.

Sperry outwardly always seemed supremely self-confident and optimistic. His times of discouragement were known only to very few. He was five feet eight inches tall, weighed about 140 pounds, had light hair, high forehead, clear blue eyes and well-shaped Yankee nose. He was energetic and quick in manner and unusually attractive.

Sperry traveled a great deal and knew practically everyone in the electrical industry both here and abroad. Edison liked to tell of an incident in 1890. Edison and Sperry were watching a large generator being started up in the Edison Power Station on Varrick Street, New York. As the switch was thrown in, sparks flew. Sperry immediately saw what was wrong, took off his coat, and with the help of a dazed young engineer changed the connection of a field coil. Edison made Sperry an honorary member of his Edison Pioneers, and whenever possible Sperry attended their annual celebrations.

Sperry was a prodigious worker. He organized his time not to be idle, and to this end he redesigned his slide rule so that it could be carried in his vest pocket at the end of his watch chain, available at all times. The scale, complete with roots, powers, and trigonometric functions, was spiralled three times around inside a circular case. A two-foot folding rule from Keuffel and Esser Company, the maker and marketer of his circular calculator, together with one of his small notebooks—which numbered 76 at the time of his death—completed the pocket equipment for work on ideas while traveling or wherever he happened to have an idle moment. Occasionally in church, he was tempted to steal a twist of the dail on his calculator. After he moved to Brooklyn, however, he frequently went to hear Dr. Cadman or Dr. Fosdick, and on these occasions he was attentive.

The *New Yorker* in its "Profile" of April 19, 1930 observed: "Although the traits of the inventor are strong in him, Sperry has none of the eccentricities common to the species. Had not an insatiable curiosity etched a kind of quizzical alertness on his face, he would have all the surface characteristics of the

conventional successful American. He is well tailored. His white hair and mustache give the required distinction; but his eyebrows are permanently raised in blended wonder and pleasure."

When he went to the theater, it was to see his favorite performers rather than the show, but he was a very responsive and enthusiastic playgoer. Whenever Sperry needed a rest—or when his assistants did—Mrs. Sperry would persuade him to stay over a few days at Bellport, or she would plan a trip to Pinehurst or Hot Springs. There, between golf games, she would act as her husband's secretary, and his assistants back in the shop would receive highly technical instructions in her lovely handwriting. Sperry liked golf, although, with his unorthodox swing, he could not drive 150 yards. However, the ball invariably went straight.

Sperry had an electrical man's amateur enthusiasm for engines in which he indulged himself almost all his life. Ideas for engine improvements kept cropping up from time to time, and in the aggregate he spent a fortune on them. He built and tested several versions of a compound supercharged gas engine and then converted it to the Diesel cycle. At engineering society meetings he entered vigorously into discussions on engines. According to an assistant, Ralph Boyer, who later became chief engineer of the Cooper-Bessemer Company, Sperry contributed greatly to the perfection of the solid fuel injection system for Diesels which is in general use today. For a nominal sum he licensed the General Electric Company and the Government on his supercharger patents, and when asked about the cost of this development he said with a broad smile, "Financially it was just an inventor's bad dream."

He never cared for luxuries and lived at home on about the scale of a well-paid Baptist minister. That was the sort of environment he liked.

His attitude toward his work is best described in his own words:

". . . My work, which has been practically continuous, never much considering hours, times, or places, has been a source of the keenest joy; and even though it may not have led to the

goal desired it has always led somewhere and added to both experience and caution in pushing forward. In the thrill of the work itself I have always felt that I have had my share of reward. From time to time, often after long periods of research, patient experimentation, and repeated changes, there have come great satisfactions. On such occasions there comes over me a welling up from within, a sort of elation, and life takes on a new and exalted aspect. This is living! These have been my times of reward."[4]

## *Summary*

Elmer Sperry combined qualities which make for success in any walk of life. He was physically and nervously tough, shrewd and persuasive, intelligent and persistent, modestly self-confident, and above all intensely interested in the world about him.

Acute observation stimulated his imagination and set in train thought processes that repeatedly culminated in important inventions. The concept of an invention led at once to action to create means to develop it to its widest usefulness. He was not academically trained but had no fear of the unknown and knew when and how to get technical advice.

In the National Academy of Sciences, Sperry enjoyed his association with men of science but modestly questioned his own credentials for membership. Nevertheless, he persuasively and fortunately for the reputation of the Academy, successfully, advocated the election of Edison who said he knew no science and was glad of it.

Sperry took great satisfaction in his sense of participation in the classic experiments of Albert A. Michelson to determine the velocity of light. Sperry had supplied the equipment, including a Sperry superpowered searchlight.

It is significant that Sperry was never a garret-starved inventor waiting for recognition. His ideas became his enterprises, his enterprises became under his management successful businesses, to be placed in due time in the hands of competent and substantial foster parents.

Elmer Sperry had the gift of attracting to himself brilliant collaborators who advanced his ideas and carried them forward

[4] From response on receiving the John Fritz Medal, December 7, 1926.

to generous fruition. His inventions and enterprises opened new fields of industrial activity which now give employment to tens of thousands.

He was inventor, promoter, manager, salesman and trader. In every role he had friends to help him. No man in our complex civilization is alone sufficient; he lives and grows in his environment. Elmer Sperry was supremely well adapted to his environment at the dawn of the electrical age, fortunate in his wife and family, and in his associates and friends.

## KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

Amer. Electro. Soc. Trans.=American Electrochemical Society Transactions
Amer. Inst. Elec. Eng. Trans.=American Institute of Electrical Engineers Transactions
Amer. Soc. Mech. Eng. Trans.=American Society of Mechanical Engineers Transactions
Elec. Jour.=Electrical Journal
Elec. Rev.=Electrical Review
Elec. World=Electrical World
Franklin Inst. Jour.=Franklin Institute Journal
Mech. Eng.=Mechanical Engineering
Proc. Eng. Club Phila.=Proceedings, Engineers' Club of Philadelphia
Sci. Amer.=Scientific American
Sci. Amer. Mo.=Scientific American Monthly
Soc. Auto. Eng. Trans.=Society of Automotive Engineers Transactions
Soc. Naval Arch. Marine Eng. Trans.=Society of Naval Architects and Marine Engineers Transactions

## LIST OF THE MORE IMPORTANT SCIENTIFIC PAPERS OF ELMER AMBROSE SPERRY

*1885*

The best form of dynamo. Elec. World, *6*, 87-88. Paper read before the National Electric Light Association, August 29, 1885.

*1890*

Operation of electric motors with high tension currents. Elec. World, *15*, 112-113. Abstract of paper read before the Chicago Electric Club.

Duplex gas engines. Elec. World, *16*, 198.

*1892*

Electricity in bituminous mining. Amer. Inst. Elec. Eng. Trans., *9*, 374-400.

*1893*

Traction and street railway trucks; more data on traction experiments. Elec. World, *22*, 413.

*1899*

Electric automobiles. Amer. Inst. Elec. Eng. Trans., *16*, 509-525.

*1900*

Automobiles as a source of revenue for central stations. Elec. Rev., *36*, 596, 608-610. Paper read before the National Electric Light Association, Chicago, May 24, 1900.

*1903*

Axle-lighting. Amer. Inst. Elec. Eng. Trans., *21,* 155-162.

The use of pyroxyline in electric storage batteries. Amer. Electro. Soc. Trans., *3,* 169-173.

*1906*

Electrochemical processes as station load equalizers. Amer. Electro. Soc. Trans., *9,* 147-152.

*1908*

Utilization of power stations for electrochemical and electrothermal processes during periods of low load. Amer. Electro. Soc. Trans., *14,* 259-261.

*1910*

The gyroscope for marine purposes. Soc. Naval Arch. Marine Eng. Trans., *18,* 143-154.

*1912*

Active type of stabilizing gyro. Soc. Naval Arch. Marine Eng. Trans., *20,* 201-215.

*1913*

Gyroscopic stabilizer for ships. Sci. Amer., *75,* 203-205.

Engineering applications of the gyroscope. Franklin Inst. Jour., *175,* 447-482.

Some graphic studies of the active gyro stabilizer. Soc. Naval Arch. Marine Eng. Trans., *21,* 181-187.

*1915*

Recent progress with the active type of gyro stabilizer for ships. Soc. Naval Arch. Marine Eng. Trans., *23,* 43-48.

*1916*

The commercial gyroscopic compass. Soc. Naval Arch. Marine Eng. Trans., *24,* 207-214.

Electrically driven gyroscope and its uses. Proc. Eng. Club Phila.

*1917*

Aerial navigation over water. Soc. Auto. Eng. Trans., *12,* 153-165.

Gyro ship stabilizers in service. Soc. Naval Arch. Marine Eng. Trans., *25,* 293-299.

*1919*

Non-rolling passenger liners—observations on a large stabilized ship in service, including the plant and economies effected by stabilization. Soc. Naval Arch. Marine Eng. Trans., *27,* 99-108.

*1920*

Non-rolling passenger liners. Sci. Amer. Mo., *1,* 232-237.

Golf without a caddy. Sci. Amer., *123,* 473.

*1921*

The gyro stabilizer for ships. Elec. Jour., *18*, 335.

What the Virginia Capes aircraft bombings show. Mech. Eng., *43*, 624.

Compounding the combustion engine. Amer. Soc. Mech. Eng. Trans., *43*, 677-716.

*1922*

Automatic steering. Soc. Naval Arch. Marine Eng. Trans., *30*, 53-57.

*1923*

The automatic pilot. International Air Congress Report, London, 406-413.

The high intensity light in night aviation. International Air Congress Report, London, 816-821.

A substitute for gasoline that will not burn. International Air Congress Report, London, 602-605.

Sperry gyro turn indicator. International Air Congress Report, 404-405.

*1927*

The light supercharged Diesel engine for use in air service. Mech. Eng., *49*, 723.

*1928*

The non destructive detection of hidden flaws. Prize-winning paper, Yearbook of Amer. Iron & Steel Inst. for 1928.

*1929*

Aeronautics and arbitration. U. S. Air Service, *14*, 37.

## LIST OF E. A. SPERRY'S PATENTS

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1882 | June 27 | 260,132 | Dynamo Electric Machine. |
| | Aug. 1 | 261,965 | Armature for Dynamo Electric Machines. |
| | Sept. 5 | 263,982 | Vehicle Wheel. |
| | Oct. 17 | 266,956 | Valve for Steam Engines. |
| | Dec. 12 | 268,956 | Dynamo Electric Machine. |
| 1883 | Oct. 16 | 286,970 | Combined Annunciator and Alarm System. |
| 1884 | Feb. 26 | 294,092 | Machine for Cutting Screw Threads. |
| | Apr. 29 | 297,866 | Electric Regulator. |
| | Apr. 29 | 297,867 | Commutator and Brush for Electric Machines. |
| | July 1 | 301,175 | Regulating Device for Electric Lamps. |
| | Sept. 9 | 304,966 | Electric Arc Lamp. |
| 1886 | June 15 | 343,651 | Vitrified Asbestos. |
| | Dec. 7 | 353,986 | Regulator. |
| | Dec. 7 | 353,987 | Motor. |
| | Dec. 7 | 353,988 | Regulator for Dynamo Electric Machines. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1886 | Dec. 7 | 353,989 | Armature. |
| | Dec. 7 | 353,990 | Regulator. |
| | Dec. 28 | 354,945 | Dynamo. |
| | Dec. 28 | 354,946 | Dynamo. |
| 1887 | Mar. 29 | 360,060 | Electric Car Brake. |
| | Apr. 26 | 361,843 | Apparatus for Distributing Power. |
| | Apr. 26 | 361,844 | Safety Device for Incandescent Lamps. |
| | Aug. 30 | 369,036 | Lightning Arrester. |
| 1888 | July 17 | 385,184 | Electric Railway. |
| 1889 | Jan. 22 | 396,439 | Electrical Switch. |
| | Feb. 19 | 397,945 | Electric Battery. |
| | Feb. 26 | 398,668 | Regulator for Dynamo Electric Machines. |
| | Mar. 26 | 400,264 | Automatic Grounding Device. |
| | June 11 | 405,187 | Electric Drilling Machine. |
| | June 11 | 405,188 | Electric Mining Machine. |
| | June 18 | 405,440 | Electric Arc Lamp. |
| | June 18 | 405,441 | Dynamo. |
| | Dec. 17 | 417,290 | Galvanic Battery. |
| | Dec. 31 | 418,245 | Gas Pressure Regulator. |
| 1890 | Jan. 7 | 418,824 | Lightning Arrester. |
| | Jan. 28 | 420,117 | Electric Regulator and Motor therefor. |
| | May 27 | 428,787 | Pick for Mining Machines. |
| | Aug. 5 | 433,551 | Gas Engine. |
| | Aug. 12 | 434,096 | Rotating Part of Dynamos and Motors. |
| | Aug. 12 | 434,097 | Power Gearing for Vehicles. |
| | Aug. 12 | 434,098 | Power Gearing for Vehicles. |
| | Aug. 12 | 434,363 | System of Transportation in Mines. |
| 1891 | Feb. 10 | 446,030 | System of Electrical Distribution for Mines. |
| | Feb. 10 | 446,031 | Electric Switch. |
| | June 9 | 453,822 | Commutator. |
| | June 23 | 454,500 | Mining Machine. |
| | July 7 | 11,177 | Power Gearing for Vehicles (reissue). |
| | Sept. 15 | 459,596 | Mineral Drilling Machine. |
| 1892 | Jan. 12 | 466,807 | Electric Trolley. |
| | Jan. 12 | 466,808 | Truck for Vehicles. |
| | Mar. 1 | 469,725 | Dynamo Electric Machines. |
| | Mar. 8 | 470,516 | Electric Locomotives. |
| | Mar. 22 | 471,151 | Trolley Wire Support. |
| | June 7 | 476,426 | Electric Generator and Motor. |
| | June 7 | 476,570 | Fuse Block for Electric Circuits. |
| | July 5 | 478,138 | Electric Mine Car. |
| | July 5 | 478,139 | Electric Locomotive. |
| | July 5 | 478,140 | Trolley Wire Splice. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1892 | July 5 | 478,141 | Mining Machine. |
| | July 5 | 478,142 | Dynamo Electric Machine or Motor. |
| | July 19 | 479,029 | Electric Arc Lamp. |
| | July 19 | 479,030 | Armature for Electric Machines. |
| | Aug. 9 | 480,525 | Electric Arc Lamp. |
| 1893 | May 23 | 497,832 | Electric Mining Machine. |
| | July 11 | 501,194 | Revolving Armature for Electric Machines. |
| | July 11 | 501,195 | Electric Locomotive. |
| | July 25 | 501,968 | Electric Railway Trolley. |
| | July 25 | 502,020 | Electric Locomotive. |
| | Aug. 15 | 503,443 | Trolley Wire Switch. |
| | Oct. 3 | 505,994 | Electro-conducting Bearing for Trolley or other Wheels. |
| | Nov. 28 | 509,776 | Electric Controller. |
| 1894 | Jan. 16 | 513,062 | Automatic Regulator for Dynamo Electric Machines. |
| | Feb. 27 | 515,374 | Electric Controller. |
| | June 5 | 520,822 | Electric Brake (acquired from C. E. Davis). |
| | Sept. 4 | 525,394 | Controller for Electric or other Motors. |
| | Sept. 4 | 525,395 | System & Apparatus for Control of Electric Vehicles. |
| 1895 | Feb. 26 | 534,676 | Clutch for Shafts. |
| | Feb. 26 | 534,974 | Electric Brake. |
| | Feb. 26 | 534,975 | Apparatus for Arresting Motion of Electrically Propelled Mechanism. |
| | Feb. 26 | 534,976 | Car Wheel. |
| | Feb. 26 | 534,977 | Electric Brake. |
| | Mar. 5 | 535,303 | Motor Truck. |
| | Mar. 5 | 535,304 | Mounting for Electric Motors. |
| | Mar. 12 | 535,511 | Electric Controller. |
| | Apr. 9 | 537,130 | Arc Rupturing Device. |
| | Sept. 10 | 545,920 | Power Transmitting Device. |
| | Dec. 17 | 551,480 | Steam Engine. |
| 1896 | Feb. 25 | 555,291 | System of Control for Electric Motors. |
| | Mar. 31 | 557,162 | Power Transmitting Device. |
| | May 19 | 560,375 | Power Gearing for Electric Cars. |
| | May 26 | 560,658 | Controller for Electric Cars. |
| | June 2 | 561,354 | Power Gearing for Electric Cars. |
| | June 16 | 562,100 | Controller for Electric Cars. |
| | June 23 | 562,498 | Power Transmitting Mechanism. |
| | June 23 | 562,499 | Coupling for Electric or other Power. |
| | June 23 | 562,500 | Coupling Transmission Device. |
| | June 23 | 562,501 | Electric Controller. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1896 | July 7 | 563,424 | Mechanical Movement. |
| | July 7 | 563,425 | Power Gearing for Electric Cars. |
| | Aug. 18 | 565,935 | Coupling Device. |
| | Aug. 18 | 565,936 | Power Gearing for Electric or other Motors. |
| | Aug. 18 | 565,937 | Electric Brake. |
| | Aug. 18 | 565,938 | Power Transmitting Gearing for Electric R. R. Trucks. |
| | Aug. 18 | 565,939 | Controller for Electric Railway Cars. |
| | Aug. 25 | 566,426 | System of Control for Electric Motors. |
| | Sept. 8 | 567,418 | Power Gearing for Trucks. |
| | Oct. 13 | 569,305 | System of Control for Electric Motors. |
| | Nov. 17 | 571,409 | Electric Brake. |
| | Nov. 17 | 571,410 | Electric Brake. |
| | Dec. 29 | 574,120 | Electric Car Brake. |
| 1897 | Feb. 16 | 577,081 | Electric Controller. |
| | Feb. 16 | 577,119 | Electric Brake. |
| | July 27 | 587,019 | Power Transmitting Device. |
| 1898 | Dec. 20 | 616,153 | Motor Vehicles. |
| 1899 | Oct. 31 | 635,815 | System & Apparatus of Controlling Electric Vehicles. |
| | Oct. 31 | 635,816 | System & Apparatus of Controlling Electric Vehicles. |
| 1900 | Jan. 9 | 640,968 | Electric Vehicle. |
| | Jan. 16 | 641,412 | System of Electric Circuits and Brakes. |
| | Feb. 13 | 643,257 | Motor Carriage. |
| | Feb. 13 | 643,258 | Motor Vehicle. |
| | Mar. 20 | 645,902 | Motor Gearing. |
| | Mar. 20 | 645,903 | Motor Vehicle Brake. |
| | Mar. 27 | 646,081 | Gearing for Motor Vehicles. |
| | Mar. 27 | 646,325 | Battery Jar or Receptacle. |
| | Apr. 3 | 646,922 | Storage Battery. |
| | Apr. 3 | 646,923 | Cellulose Envelope for Elements of Storage Batteries. |
| | May 8 | 649,003 | Envelope for Storage Batteries. |
| | May 15 | 649,491 | Electric Storage Battery. |
| | May 22 | 649,998 | Element for Storage Batteries. |
| | Oct. 23 | 660,318 | Apparatus for Governing and Controlling Marine and other Engines. |
| | Oct. 30 | 660,805 | Actuating device for Railway Appliances. |
| | Oct. 30 | 660,825 | Actuating device for Railway Appliances. |
| 1901 | | 688,749 | Storage Battery Tray or Case. |
| 1902 | Jan. 14 | 691,324 | Pigment and the Product thereof from Ferrous Liquors. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1902 | Mar. 25 | 696,209 | Envelope for Battery Electrodes. |
| | July 1 | 703,673 | Electric Battery & Mounting same. |
| | July 1 | 703,674 | Correction for Batteries. |
| | Nov. 4 | 713,020 | Manufacturing Elements for Storage Batteries. |
| | Dec. 16 | 716,125 | Electric Railway. |
| 1903 | Mar. 24 | 723,326 | Armored Element for Electric Batteries. |
| | Mar. 24 | 723,327 | Storage Battery. |
| | Mar. 24 | 723,328 | Storage Battery. |
| | Mar. 24 | 723,329 | Manufacture of Envelopes for Storage Batteries. |
| | May 26 | 729,100 | Separator for Storage Batteries. |
| | June 30 | 732,130 | System of Control for Electrically Propelled Trains. |
| 1904 | Jan. 26 | 750,471 | System of Electrical Generation, Distribution and Control. |
| | Jan. 26 | 750,497 | System of Electrical Generation, Distribution and Control. |
| | Jan. 26 | 750,498 | Power Transmitting Mechanism. |
| | Jan. 26 | 750,499 | Power Transmitting Mechanism. |
| | Jan. 26 | 750,500 | System of Electrical Generation, Distribution and Control. |
| | Aug. 16 | 767,604 | Frictional Driving Mechanism. |
| | Oct. 18 | 772,679 | Electric Rackrail. |
| | | 772,680 | Rackrail for Locomotives. |
| | Oct. 25 | 772,971 | Rackrail. |
| | Oct. 25 | 773,235 | Logarithmic Calculator. |
| | Nov. 1 | 773,685 | Storage Battery Electrode. |
| | Nov. 1 | 773,686 | Storage Battery. |
| 1905 | Feb. 7 | 781,795 | Storage Battery Electrode. |
| 1906 | Oct. 23 | 833,760 | Regulating Apparatus. |
| 1907 | Apr. 9 | 849,432 | Electric Locomotive. |
| | Oct. 1 | 867,436 | Lead Pigment and Similar Compounds. |
| | Nov. 26 | 872,092 | Detinning and Recovering Merchantable Iron from Tin Plate Scrap. |
| | Nov. 26 | 872,205 | Producing Stannic Chloride. |
| | Dec. 10 | 873,699 | Detinning. |
| | Dec. 17 | 873,804 | Electric Lighting. |
| | Dec. 17 | 874,040 | Detinning and Producing Tin Compounds and other Products. |
| | Dec. 24 | 874,707 | Electrolytic Refining of Tin. |
| | Dec. 31 | 875,632 | Detinning and Producing Tin Compounds and other Products. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1908 | Jan. 21 | 877,243 | Apparatus for making Stannic Chloride. |
| | Jan. 21 | 877,244 | Purifying Stannic Chloride. |
| | Jan. 21 | 877,245 | Effecting Reactions. |
| | Jan. 21 | 877,246 | Effecting Reactions between Solids and Gases. |
| | Jan. 21 | 877,247 | Making Stannic Chloride. |
| | Jan. 21 | 877,248 | Making Stannic Chloride. |
| | Feb. 18 | 879,596 | Reclaiming Tin Scrap. |
| | Mar. 17 | 882,354 | Making Stannic Chloride. |
| | Mar. 31 | 883,500 | Detinning. |
| | Apr. 21 | 885,391 | Apparatus for Effecting Reactions. |
| | May 12 | 887,538 | Preparing Pure Tin Compounds. |
| | Sept. 1 | 897,312 | Electric Locomotive. |
| | Sept. 1 | 897,796 | Preparing Merchantable Iron and Tin Compound from Tin Plate Scrap. |
| | Oct. 13 | 901,266 | Preparing Merchantable Iron from Tin Plate Scrap. |
| | Dec. 1 | 905,602 | Dehydrating Moist Chloride. |
| | Dec. 8 | 906,321 | Preparing Merchantable Iron from Tin Plate Scrap. |
| | Dec. 29 | 907,907 | Steadying Device for Vehicles. |
| 1910 | June 14 | 961,549 | Cathode. |
| | Aug. 23 | 967,990 | Producing Clear Stannic Chloride Solutions. |
| 1911 | No Patents. | | |
| 1912 | Feb. 27 | 1,018,591 | Valve. |
| | Dec. 31 | 1,048,905 | Centrifugal Machine. |
| 1913 | Sept. 2 | 1,071,815 | Apparatus for Determination of Periodic Motion. |
| 1914 | Nov. 10 | 1,116,855 | Electric Heater. |
| | May 26 | 1,097,826 | Electrolytic Cell. |
| 1915 | Apr. 20 | 1,136,058 | System of Power Transmission. |
| | May 4 | 1,137,804 | Vehicle Control. |
| | June 8 | 1,141,985 | Gas Engine. |
| | Aug. 17 | 1,150,311 | Ship Gyroscope. |
| 1916 | June 13 | 1,186,856 | Gyroscopic Apparatus. |
| | Aug. 15 | 1,194,889 | Internal Combustion Engine. |
| | Oct. 31 | 1,203,151 | Periscope Azimuth Indicator. |
| 1917 | Feb. 13 | 1,215,425 | Plotting Indicator. |
| | May 15 | 1,226,132 | Combustion Engine. |
| | May 22 | 1,227,210 | Method of Operating Flaming Arc Lights for Projectors. |
| | July 10 | 1,232,619 | Ship Stabilizing and Rolling Apparatus. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1917 | Aug. 14 | 1,236,993 | Gyroscopic Stabilizer. |
| | Aug. 28 | 1,238,503 | Automatic Gun Pointing. |
| | Oct. 2 | 1,242,065 | Ship's Gyroscopic Compass Set. |
| 1918 | Feb. 19 | Re.14,435 | Ship Stabilizing and Rolling Apparatus. |
| | Feb. 5 | 1,255,480 | Gyroscopic Navigation Apparatus. |
| | Feb. 26 | 1,257,417 | Gearing. |
| | Aug. 6 | 1,274,622 | Speed and Direction Indicator for Aircraft. |
| | Sept. 17 | 1,279,471 | Gyroscopic Compass. |
| | Oct. 22 | 1,282,133 | Electrode Holder for Searchlights. |
| | Nov. 5 | 1,283,943 | Reflecting Surface for Optical Instruments. |
| 1919 | Mar. 4 | 1,296,439 | Multiple Turret Target Indicator. |
| | Mar. 4 | 1,296,440 | Repeater System for Gyro Compasses. |
| | Apr. 15 | 1,300,890 | Navigational Instrument. |
| | Apr. 15 | 1,301,014 | Electric Drive for Gyroscopes. |
| | Apr. 29 | 1,302,488 | Electric Arc Light. |
| | Aug. 5 | 1,312,084 | Torpedo Gyroscope. |
| | Aug. 5 | 1,312,085 | Stabilizing Gyroscope. |
| | Aug. 26 | 1,314,157 | Electrical and Gyroscopic Apparatus for Torpedoes. |
| | Oct. 7 | 1,318,302 | Rotor for Gyroscopic Stabilizers. |
| | Oct. 14 | 1,318,701 | Method of Searchlight Ventilation. |
| | Nov. 18 | 1,321,947 | Electric Battery. |
| | Dec. 23 | 1,325,810 | Multiple Expansion Internal Combustion Engine. |
| 1920 | Mar. 9 | 1,333,224 | Submarine Net and Method of Laying the same. |
| | Mar. 9 | 1,333,238 | Means for Tracing and Locating Submarine Boats. |
| | June 1 | 1,342,397 | Controlling Mechanism for Ships' Gyroscopes. |
| | June 1 | 1,342,398 | Electrode for Searchlights and Method of making the same. |
| | Oct. 19 | 1,356,505 | System of Gunfire Control. |
| | Nov. 2 | 1,357,827 | Method of Operating Electrodes for Searchlights. |
| | Nov. 9 | 1,358,258 | Stabilizing Gyroscope. |
| | Nov. 30 | 1,360,694 | Navigational Apparatus. |
| | Dec. 14 | 1,362,574 | Light Extinguisher for Arc Lamps. |
| | Dec. 14 | 1,362,575 | Feeding Mechanism for Searchlights. |
| | Dec. 21 | 1,362,753 | Wind Driven Generator for Aircraft. |
| | Dec. 21 | 1,362,754 | Cooling and Lubricating System for Bearings. |
| 1921 | Jan. 25 | 1,366,430 | Dead Beat Inclinometer. |
| | Feb. 8 | 1,368,226 | Aeroplane Stabilizer. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1921 | Feb. 8 | 1,368,227 | Osmotic Diaphragm. |
| | Mar. 17 | 1,378,291 | Diving and Governing Means for Torpedoes. |
| | May 31 | 1,379,881 | Arc Striking and Extinguishing Apparatus. |
| | July 19 | 1,384,868 | Dirigible Gravity Bomb. |
| | Aug. 9 | 1,387,018 | Lubricating and Cooling System for Gyroscopes. |
| | Oct. 18 | 1,393,844 | Observation Apparatus for Submarines. |
| | Oct. 18 | 1,393,845 | Gyroscope. |
| | Dec. 6 | 1,399,032 | Gyroscopic Roll and Pitch Recorder. |
| | Dec. 27 | 1,401,743 | Method and Apparatus for Separating Foreign Substances from Lead Matter. |
| 1922 | Jan. 10 | 1,403,062 | Correction Device for Repeater Compasses. |
| | Jan. 17 | 1,403,876 | Trench Searchlight. |
| | Feb. 21 | 1,407,491 | Turn Indicator. |
| | Apr. 11 | 1,412,757 | Military Searchlight. |
| | Apr. 11 | 1,412,758 | Sighting Device for Ordnance. |
| | May 9 | 1,415,614 | Depth Controlled Mine. |
| | May 9 | 1,415,847 | Launching Mechanism for Aeroplanes. |
| | June 6 | 1,418,335 | Automatic Pilot for Aeroplanes. |
| | July 4 | 1,421,854 | Gyroscopic Apparatus for Torpedoes. |
| | Aug. 15 | 1,426,336 | Rotor for Gyroscopes. |
| | Aug. 15 | 1,426,337 | Signalling Apparatus for Detecting Submarines. |
| | Aug. 15 | 1,426,338 | Visual Signal Means. |
| | Aug. 15 | 1,426,339 | Wire Wound Gyro Rotor. |
| | Aug. 29 | 1,427,560 | Means for Detecting Submarine Boats. |
| | Sept. 5 | 1,428,507 | Wireless Repeater System. |
| | Oct. 17 | 1,432,214 | Fuel Injection and Igniting Means for Oil Engines. |
| | Dec. 19 | 1,439,028 | Universally Mounted Searchlight. |
| 1923 | Feb. 20 | 1,445,805 | Gyroscopic Navigational Apparatus. |
| | Feb. 20 | 1,446,276 | Gyroscopic Apparatus for Torpedoes. |
| | Apr. 17 | 1,452,482 | Means for Governing the Rolling of Ships. |
| | Apr. 17 | 1,452,484 | Method of Gunfire Control for Battleships. |
| | Apr. 24 | 1,452,620 | Method of Treating White Lead. |
| | May 8 | 1,454,085 | Electric Indicator for Vibrations of the Air. |
| | June 26 | 1,459,902 | Searchlight for the Guidance for Detection of Aircraft. |
| | Sept. 18 | 1,468,330 | Synchronous Transmission System. |
| 1924 | Jan. 1 | 1,479,630 | Cooling Motion Picture Projectors and Films. |
| | Jan. 15 | 1,481,248 | Automatic Sighting Mechanism for Aircraft Guns. |
| | Feb. 12 | 1,483,489 | Signalling System for Warships. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1924 | Feb. 19 | 1,483,992 | Means for Spinning up Gyroscopes on Aircraft. |
| | Mar. 18 | 1,487,282 | Fire Control System. |
| | June 24 | 1,499,321 | Gyroscopic Compass. |
| | Sept. 2 | 1,506,784 | Submarine Mine. |
| | Sept. 2 | 1,506,785 | Gravity Bomb. |
| | Sept. 23 | 1,509,267 | Aeroplane Gun. |
| | Oct. 7 | Re.15,924 | Wireless Repeater System. |
| | Oct. 14 | 1,511,240 | Cooling Means for Gyroscopes. |
| | Dec. 16 | 1,519,272 | Mercury Cooling Transfer Valve. |
| 1925 | Jan. 13 | 1,522,924 | Position Indicator for Aerocraft. |
| | Feb. 10 | 1,515,963 | Shoal Water Contact Mine. |
| | Feb. 24 | 1,527,932 | Alarm Device for Gyro Compasses. |
| | Apr. 28 | 1,535,633 | Submarine Contact Mine. |
| | May 12 | 1,537,713 | Drag Rudder for Gravity Bombs. |
| | Aug. 11 | 1,548,958 | Aviation Beacon. |
| | Oct. 27 | 1,558,514 | Multiple Gyro Ship Stabilizer. |
| | Nov. 3 | 1,560,435 | Apparatus for Testing Gyroscopic Compasses. |
| | Dec. 1 | 1,563,934 | Gyroscopic Inclinometer for Aeroplanes. |
| 1926 | Apr. 6 | 1,579,669 | Wireless Repeater System. |
| | Sept. 21 | 1,600,569 | Method of and Means for Balancing Masses. |
| | Sept. 21 | 1,600,651 | Accelerating Means for Automotive Vehicles. |
| | Dec. 21 | 1,611,253 | Speed-Measuring Device. |
| 1927 | Feb. 8 | 1,617,310 | Repeater Compass. |
| | Apr. 26 | 1,626,123 | Gyrocompass Relay Transmitter. |
| | Apr. 26 | 1,626,363 | Gravity Bomb. |
| | May 3 | 1,627,210 | Valve Mechanism for Combustion Engines. |
| | May 17 | 1,629,236 | Means for Indicating Loss of Synchronism in Transmission Systems. |
| | Aug. 9 | 1,638,417 | Ship's Signalling or Broadcasting Device. |
| | Aug. 16 | 1,639,062 | Piston for Internal-Combustion Engines. |
| | Sept. 6 | 1,641,301 | Searchlight Cooling and Ventilating Means. |
| | Nov. 15 | 1,648,968 | Means for Cooling the Pistons of Heat Engines. |
| | Dec. 6 | 1,651,845 | Gyroscopic Pendulum. |
| 1928 | Jan. 24 | 1,656,962 | Synchronizing Mechanism. |
| | May 15 | 1,669,882 | Searchlight for the Guidance or Detection of Aircraft. |
| | May 29 | 1,671,616 | Logarithmic Calculator. |
| | July 17 | 1,677,305 | Two Cycle Supercharging Combustion Engine. |
| | July 31 | 1,678,714 | Means for Preventing Racing of Ship's Engines. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1928 | Aug. 28 | 1,682,357 | Internal Combustion-Engine Cylinder. |
| | Aug. 28 | 1,682,358 | Combustion-Engine Drive for Ships. |
| | Sept. 18 | 1,684,809 | Cooling Means for Internal Combustion Engines. |
| | Oct. 9 | 1,686,774 | Supporting Means for Golf Bags. |
| | Oct. 23 | 1,688,403 | Piston for Internal-Combustion Engines. |
| | Oct. 23 | 1,688,559 | Gyroscopic Line of Sight Stabilizer. |
| | Oct. 23 | 1,688,691 | Transmission System for Automotive Vehicles. |
| | Oct. 23 | 1,688,761 | Wakeless Torpedo. |
| | Dec. 4 | 1,693,966 | Oil-Burning Engine. |
| 1929 | Jan. 1 | 1,697,292 | Engine and the Transmission of Power therefrom. |
| | Jan. 15 | 1,699,379 | Method of Refining Crude Fuel Oil. |
| | Mar. 5 | 1,704,489 | Locking Device for Gyroscopes. |
| | Apr. 16 | 1,709,377 | Beacon System for Night Flying. |
| | May 7 | 1,711,703 | Valve Mechanism for Internal-Combustion Engines. |
| | May 21 | 1,713,929 | Automatic Projector Lamp. |
| | May 21 | 1,714,145 | Crankless Engine. |
| | Nov. 5 | 1,734,353 | Automatic Launching Devices for Airplanes. |
| 1930 | Mar. 18 | 1,751,254 | Fuel Injecting and Igniting Means for Oil Engines. |
| | Apr. 22 | 1,755,340 | Director Firing System. |
| | June 10 | 1,763,377 | Sounding Device. |
| 1931 | Jan. 13 | 1,788,412 | Oil Engine. |
| | Jan. 13 | 1,788,807 | Control Gyro. |
| | Feb. 17 | 1,792,937 | Wireless-Controlled Aerial Torpedo. |
| | Apr. 14 | 1,800,365 | Means for Preventing Pitching of Ships. |
| | May 5 | 1,803,876 | Combustion Engine Locomotive. |
| | May 5 | 1,804,380 | Fissue Detector for Steel Rails. |
| | May 26 | 1,806,652 | Automatic Accelerator. |
| | July 7 | 1,812,994 | Borehole Inclination Recorder. |
| | Aug. 11 | 1,818,103 | Automatic Pilot. |
| | Aug. 11 | 1,818,104 | Means for Controlling Dirigible Aircraft. |
| | Aug. 25 | 1,820,505 | Fissure Detector for Metals. |
| | Nov. 3 | 1,830,041 | Method and Means for Imparting Intelligence. |
| | Dec. 22 | 1,837,633 | Roadway Inspecting Means. |
| | Dec. 29 | 1,838,965 | Automatic Steering Device. |
| 1932 | Feb. 9 | 1,843,959 | Track Recorder System. |
| | Mar. 22 | 1,850,640 | Self-Synchronous Transmission System. |
| | Mar. 22 | 1,850,780 | Self-Synchronous Transmission System. |
| | Mar. 22 | 1,850,978 | Recorder for Ships. |

| *Year* | *Date* | *Number* | *Description* |
|---|---|---|---|
| 1932 | Apr. 26 | 1,855,929 | Engine. |
| | July 12 | 1,867,334 | Automatic Steering Mechanism for Dirigible Aircraft. |
| | July 19 | 1,867,682 | Improvement in Combustion Chamber for Combustion Engines. |
| | July 19 | 1,867,683 | Combustion Engine. |
| | July 19 | 1,867,684 | Means for Preventing the Vibration of Crank Shafts. |
| | July 19 | 1,867,685 | Fissure Detector for Magnetic Materials. |
| | Aug. 16 | 1,871,476 | Marine Aircraft. |
| | Aug. 30 | 1,874,067 | Flaw Detector for Irregular Objects. |
| | Aug. 30 | 1,874,714 | Variable Pitch Propeller. |
| | Oct. 4 | 1,880,994 | Indicator for Aircraft. |
| 1933 | May 2 | 1,907,014 | Variable Pitch Propeller. |

REISSUE PATENTS

| | | | |
|---|---|---|---|
| 1932 | Feb. 2 | 18,344 | Method of Refining Oil. |
| | Aug. 2 | 18,555 | Fissure Detector for Metals. |

A few years before Sperry died he licensed the government and the General Electric Company for a nominal sum on his basic patent coverage for the art of supercharging internal combustion engines. The basic supercharging patents were 1,141,985 of 1915 and 1,226,132 of 1917.